DEKRA Testing and Certification, S.A.U.
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c/ Severo Ochoa nº 2 · 29590 Campanillas · Málaga · España
C.I.F. A29 507 456

DEKRA

ENAC ENSAYOS Nº 51/LE147

Test report No:
NIE: 64610RRF.002

Partial Test report

REFERENCE STANDARD:
USA FCC Part 24 & Part 27
CANADA IC RSS-130. RSS-133. RSS-139

(*) Identification of item tested	nRF9160 IOT Module
(*) Trademark	nRF91
(*) Model and /or type reference tested	nRF9160
Other identification of the product	SW version: mfw_nrf9160_1.1.2-148 HW version: nRF9160-SICA-B1A FCC ID: 2ANPO00NRF9160 IC: 24529-NRF9160 IMEI TAC: 35265610
(*) Features	LTE Cat-M1, LTE-NB1, GPS
Applicant	NORDIC SEMICONDUCTOR ASA Otto Nielsens Vei 12, 7052 Trondheim, Norway
Test method requested. standard	USA FCC Part 24 10-1-19 Edition. USA FCC Part 27 10-1-19 Edition. CANADA IC RSS-130 Issue 1. Oct. 2013. CANADA IC RSS-133 Issue 6. Jan. 2013. CANADA IC RSS-139 Issue 3. Jul. 2015. ANSI C63.26 – 2015 KDB 971168 D01 Power Meas License Digital Systems v03r01, April. 2018.
Approved by (name / position & signature)	Rafael López Martín EMC Consumer & RF Lab. Manager RAFAEL LÓPEZ MARTÍN 2020.08.25 14:13:46 +02'00'
Date of issue	2020-08-25
Report template No	FDT08_22 (*) "Data provided by the client"

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DEKRA Testing and Certification is a laboratory with a measurement site in compliance with the requirements of RSS 212. Issue 1 (Provisional) and has been added to the list of filed sites of the Canadian Certification and Engineering Bureau. Reference File Number: ISED 4621A-4.

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Uncertainty

Uncertainty (factor k=2) was calculated according to the DEKRA Testing and Certification internal document PODT000.

Data provided by the client

The following data has been provided by the client:

1. Information relating to the description of the sample ("Identification of the item tested", "Trademark", "Model and/or type reference tested").

2. The sample consists of nRF9160 IOT Module.

DEKRA Testing and Certification S.A.U. declines any responsibility with respect to the information provided by the client and that may affect the validity of results.

Usage of samples

Samples undergoing test have been selected by: the client.

Sample S/01 is composed of the following elements:

Control Nº	Description	Model	Serial Nº	Date of reception
64610D/002	nRF9160 IOT Module	nRF9160	IMEI: 352656102628230	2020/04/14

1. Sample S/01 has undergone the following test(s):

All tests indicated in appendixes A and B for GEN2 device.

Auxiliary sample S/02 is composed of the following elements:

Control Nº	Description	Model	Serial Nº	Date of reception
59965/013	nRF9160 IOT Module	nRF9160	IMEI: 352656100299349	2019/03/25

1. Sample S/02 has undergone the following test(s):

Auxiliary sample to perform measurements for GEN1 device for conducted RF output power comparison indicated in appendixes A and B.

Test sample description

<table>
<tr><td rowspan="5">Ports…… :</td><td rowspan="2">Port name and description</td><td colspan="3">Cable</td></tr>
<tr><td>Specified length [m]</td><td>Attached during test</td><td>Shielded</td></tr>
<tr><td>LTE RF</td><td>2</td><td>☒</td><td>☒</td></tr>
<tr><td>GPS</td><td>2</td><td>☐</td><td>☐</td></tr>
<tr><td>BTLE</td><td></td><td>☐</td><td>☐</td></tr>
<tr><td></td><td></td><td>☐</td><td>☐</td></tr>
<tr><td>Supplementary information to the ports…… :</td><td colspan="4">N/A</td></tr>
<tr><td rowspan="3">Rated power supply .....:</td><td colspan="2" rowspan="2">Voltage and Frequency</td><td colspan="5">Reference poles</td></tr>
<tr><td>L1</td><td>L2</td><td>L3</td><td>N</td><td>PE</td></tr>
<tr><td>☐</td><td>AC:</td><td>☐</td><td>☐</td><td>☐</td><td>☐</td><td>☐</td></tr>
<tr><td>☒</td><td colspan="6">DC: 3.0-5.5V</td></tr>
<tr><td>Rated Power .....:</td><td colspan="4">1W</td></tr>
<tr><td>Clock frequencies.....:</td><td colspan="4">32kHz, 32MHz</td></tr>
<tr><td>Other parameters.....:</td><td colspan="4">--</td></tr>
<tr><td>Software version .....:</td><td colspan="4">mfw_nrf9160_1.1.2_148</td></tr>
<tr><td>Hardware version.....:</td><td colspan="4">nRF9160-SICA-B1A</td></tr>
</table>

Dimensions in cm (L x W x D).....:	11x16x1.1mm			
Mounting position .....:	☐	Table top equipment		
	☐	Wall/Ceiling mounted equipment		
	☐	Floor standing equipment		
	☐	Hand-held equipment		
	☒	Other: SMD Module		
Modules/parts.....:	Module/parts of test item		Type	Manufacturer
	N/A			
Accessories (not part of the test item) .....:	Description		Type	Manufacturer
	N/A			
Documents as provided by the applicant.....:	Description		File name	Issue date
	User manual		4418_1315-v1.2 /2020-04-30-nRF9160_Objective_Product_Spec	30-Apr-2020
	Cover markings		nRF9160_SiP marking	15-Jun-2020

Copy of marking plate:

Identification of the client

NORDIC SEMICONDUCTOR ASA
Otto Nielsens Vei 12, 7052 Trondheim, NORWAY

Testing period and place

Test Location	DEKRA Testing and Certification S.A.U.
Date (start)	2020-05-14
Date (finish)	2020-05-19

Document history

Report number	Date	Description
64610RRF.002	2020-07-08	First release
64610RRF.002A1	2020-08-25	Second release: modification of sw and hw version and DC voltage range declared by manufacturer in “Test sample description”. Correction on Vnom voltage value in “Test conditions”. Inclusion of conducted RF output power comparison between GEN2 and GEN1 devices. This modification test report cancels and replaces the test report 64610RRF.002

Environmental conditions

In the control chamber, the following limits were not exceeded during the test:

Temperature	Min. = 15 ºC Max. = 35 ºC
Relative humidity	Min. = 20 % Max. = 75 %
Air pressure	Min. = 860 mbar Max. = 1060 mbar

In the semianechoic chamber, the following limits were not exceeded during the test.

Temperature	Min. = 15 ºC Max. = 35 ºC
Relative humidity	Min. = 20 % Max. = 75 %
Air pressure	Min. = 860 mbar Max. = 1060 mbar

In the chamber for conducted measurements, the following limits were not exceeded during the test:

Temperature	Min. = 15 ºC Max. = 35 ºC
Relative humidity	Min. = 20 % Max. = 35 %
Air pressure	Min. = 860 mbar Max. = 1060 mbar

Remarks and comments

The tests have been performed by the technical personnel: José Manuel Jimenez, Cristina Calle and Nicolás Salguero.

Used instrumentation:

Conducted Measurements

		Last Cal. date	Cal. due date
1.	DC power supply R&S NGPE 40/40	2018/02	2021/02
2.	Universal Radio communication Tester ROHDE AND SCHWARZ CMW50	2020/04	2021/04

Radiated Measurements

		Last Cal. date	Cal. due date
1.	Semianechoic Absorber Lined Chamber ETS FACT3 200STP	N.A.	N.A.
2.	Hibrid Bilog antenna SUNOL SCIENCES CORPORATION JB6	2017/09	2020/09
3.	Broadband Horn antenna 1-18 GHz SCHWARZBECK BBHA 9120 D	2019/11	2022/11
4.	Broadband Horn antenna 18-40 GHz SCHWARZBECK BBHA 9170	2018/07	2021/07
5.	Signal and Spectrum Analyser ROHDE AND SCHWARZ FSV40	2019/09	2021/09
6.	EMI Test Receiver 9kHz – 7GHz ROHDE AND SCHWARZ ESR7	2019/10	2021/10
7.	RF pre-amplifier, G>40dB, 1-18 GHz BONN ELEKTRONIK BLMA 0118-1M	2020/05	2021/05
8.	RF pre-amplifier, G>30dB, 18-40 GHz BONN ELEKTRONIK BLMA 1840-1M	2019/02	2021/02
9.	Universal Radio communication Tester ROHDE AND SCHWARZ CMW500	2020/04	2021/04

Testing verdicts

Not applicable :	N/A
Pass :	P
Fail :	F
Not measured :	N/M

Summary

FCC PART 24/IC RSS-133 PARAGRAPH Requirement – Test case	Verdict	Remark
Clause 24.232/RSS-133 Clause 6.4: RF output power	P	(2)
Clause 2.1047/RSS-133 Clause 6.2: Modulation characteristics	NM	(1)
Clause 24.235/RSS-133 Clause 6.3: Frequency stability	NM	(1)
Clause 2.1049: Occupied Bandwidth	NM	(1)
Clause 24.238/RSS-133 Clause 6.5: Spurious emissions at antenna terminals	NM	(1)
Clause 24.238/RSS-133 Clause 6.5: Radiated emissions	P	
Supplementary information and remarks: (1) Test not requested. Only RF Output Power and Radiated emissions tests were tested in the worst case. (2) Peak-to-average power ratio (PAPR) was not tested.		

FCC PART 27 / RSS-139 / RSS-130 PARAGRAPH Requirement – Test case	Verdict	Remark
Clause 27.50 / RSS-139 Clause 6.5. / RSS-130 Clause 4.4.: RF output power	P	(2)
Clause 2.1047 / RSS-139 Clause 6.2. / RSS-130 Clause 4.1.: Modulation characteristics	NM	(1)
Clause 27.54 / RSS-139 Clause 6.4. / RSS-130 Clause 4.3.: Frequency stability	NM	(1)
Clause 2.1049: Occupied Bandwidth	NM	(1)
Clause 27.53 / RSS-139 Clause 6.6. / RSS-130 Clause 4.6.: Spurious emissions at antenna terminals	NM	(1)
Clause 27.53 / RSS-139 Clause 6.6. / RSS-130 Clause 4.6.: Radiated emissions	P	
Supplementary information and remarks: (1) Test not requested. Only RF Output Power and Radiated emissions tests were tested in the worst case. (2) Peak-to-average power ratio (PAPR) was not tested.		

Appendix A: Test results for FCC Part 24 / RSS-133

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TEST CONDITIONS

Power supply (V):

Vnominal = 3.8 Vdc

Type of power supply = DC Voltage from external power supply

Type of antenna = Integral antenna.

Declared Gain for antenna = 4.4 dBi.

TEST FREQUENCIES:

NBIoT. π/2 - BPSK AND π/4 - QPSK MODULATION (BAND 2)

Channel (Frequency. MHz)		
Lowest	Middle	Highest
18602 (1850.2)	18900 (1880)	19198 (1909.8)

NOTE: Band 2 is completely included in band 25. so the channels of band 25 were tested to give conformity to the assigned block.

NBIoT. π/2 - BPSK AND π/4 - QPSK MODULATION (BAND 25)

Channel (Frequency. MHz)		
Lowest	Middle	Highest
26042 (1850.2)	26365 (1882.5)	26688 (1914.8)

RF Output Power

SPECIFICATION

FCC §2.1046 and §24.232

Mobile/portable stations are limited to 2 Watts (33 dBm) Effective Isotropic Radiated Power (E.I.R.P.).
The peak-to-average ratio (PAR) of the transmission shall not exceed 13 dB.

RSS-133. Clause 6.4.

The peak-to-average power ratio (PAPR) shall not exceed 13 dB for more than 0.1% of the time using a signal corresponding to the highest PAPR during periods of continuous transmission.

METHOD

The conducted RF output power measurements were made at the RF output terminals of the EUT using the power meter of the Universal Radio Communication tester R&S CMW500. selecting maximum transmission power of the EUT and different modes of modulation.

The maximum equivalent isotropically radiated power (e.i.r.p.) is calculated by adding the declared maximum antenna gain (dBi).

The EUT was controlled via the Universal Radio Communication tester R&S CMW500 selecting maximum transmission power of the EUT and different modes of modulation.

TEST SETUP

Conducted average power.

RESULTS

MAXIMUM OUTPUT POWER (CONDUCTED).

NBIoT. BAND 25.

Ch	Freq. (MHz)	Modulation	BW (kHz)	Num. tone	Offset Tone	Average Power (dBm)
26042	1850.2	π/2 - BPSK	3.75	1	0	23.38
				1	47	23.21
			15	1	0	22.63
				1	11	22.57
		π/4 - QPSK	3.75	1	0	23.15
				1	47	23.22
			15	1	0	22.56
				1	11	22.62
				3	0	23.10
				3	6	23.12
				6	0	22.25
				6	6	22.19
				12	0	21.27
26365	1882.5	π/2 - BPSK	3.75	1	0	23.10
				1	47	23.04
			15	1	0	23.16
				1	11	23.14
		π/4 - QPSK	3.75	1	0	23.11
				1	47	23.06
			15	1	0	23.18
				1	11	23.16
				3	0	23.00
				3	6	23.10
				6	0	22.18
				6	6	22.18
				12	0	21.17
26688	1914.8	π/2 - BPSK	3.75	1	0	22.96
				1	47	22.89
			15	1	0	22.98
				1	11	22.95
		π/4 - QPSK	3.75	1	0	22.95
				1	47	22.90
			15	1	0	22.98
				1	11	23.00
				3	0	22.91
				3	6	22.94
				6	0	21.93
				6	6	22.01
				12	0	20.99

NBIoT BAND 25.

Channel	Measured maximum average power (dBm) at antenna port	Maximum declared antenna gain (dBi)	Maximum equivalent isotropically radiated power (E.I.R.P.) (dBm)	Maximum effective radiated power E.R.P. (dBm)
Lowest	23.38	4.4	27.78	25.63
Middle	23.18	4.4	27.58	25.43
Highest	23.00	4.4	27.40	25.25
Measurement uncertainty (dB)	<±1.58			

Verdict: PASS

GEN2 AND GEN1 OUTPUT POWER COMPARISON (CONDUCTED).

LTE. BAND 25.

The results in the next table shows the maximum difference between GEN2 and GEN1 devices for conducted output power measurements.

Maximum conducted output power difference between GEN2 and GEN1 (dB)	0.48

Measurement uncertainty (dB)	<±1.58

Radiated emissions

SPECIFICATION

FCC § 24.238. RSS-133 Clause 6.5.

The power of emissions shall be attenuated below the transmitter power (P) by a factor of at least 43 + 10 log (P) dB. P in watts.

METHOD

The measurement was performed with the EUT inside an anechoic chamber. The spectrum was scanned from 30 MHz to at least the 10th harmonic of the highest frequency generated within the equipment.
The EUT was placed on a non-conductive stand at a 3 meter distance from the measuring antenna.

Detected emissions were maximized at each frequency by rotating the EUT and adjusting the measuring antenna height and polarization. The maximum field strength (dBµV/m) is measured and recorded.

The maximum field strength (dBµV/m) of each detected emission at less than 20 dB respect to the limit is converted to an equivalent EIRP level (dBm) according to ANSI C63.26 with the formula:

EIRP (dBm) = E (dBµV/m) + 20log(D) - 104.8; where D is the measurement distance (in the far field region) in m. D = 3 m

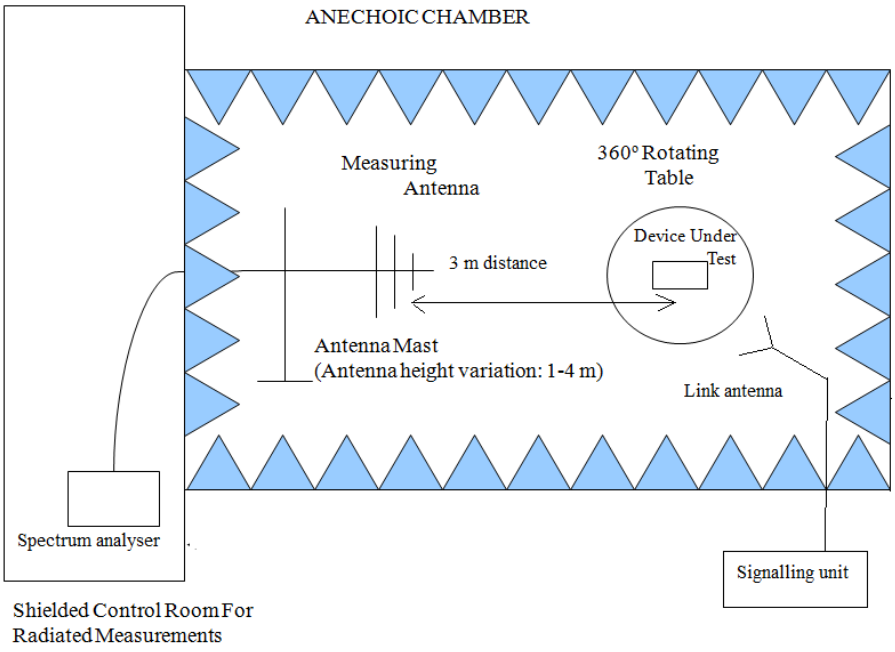
Measurement Limit:

According to specification. the power of emissions shall be attenuated below the transmitter power (P) by a factor of at least 43 + 10 log (P) dB. P in watts.
At Po transmitting power. the specified minimum attenuation becomes 43+10log (Po) and the level in dBm relative Po becomes:

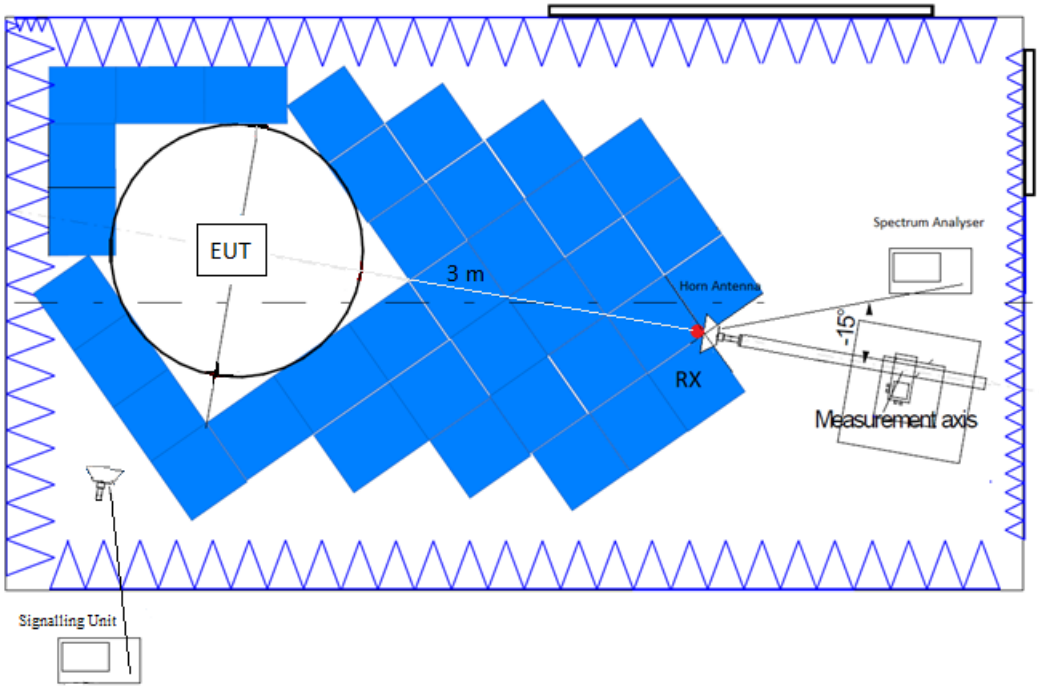
Po (dBm) – [43 + 10 log (Po in mwatts) - 30] = - 13 dBm

TEST SETUP

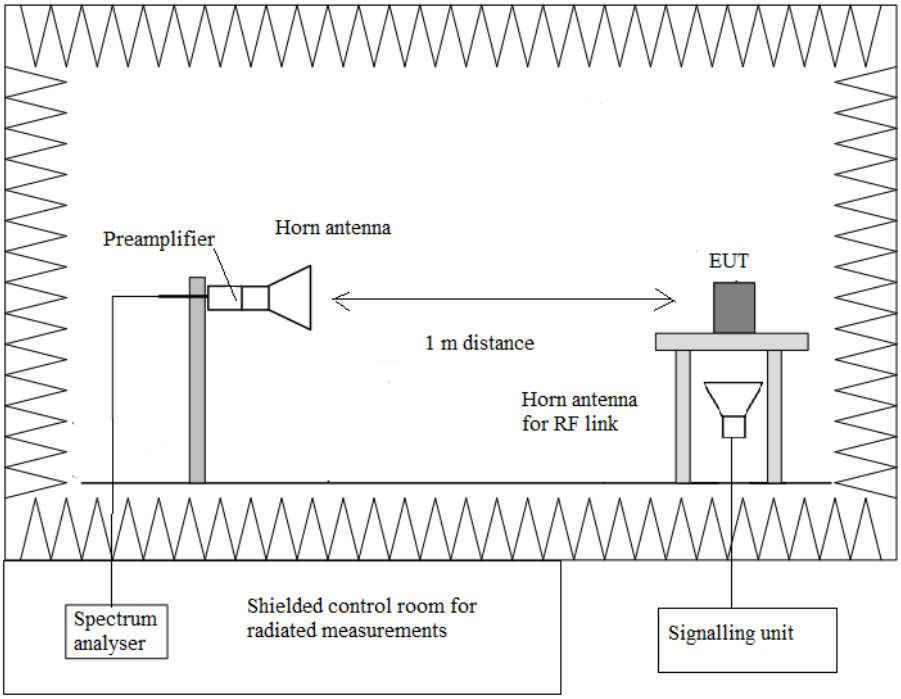
Radiated measurements below 1 GHz.



Radiated measurements between 1 GHz to 17GHz.



Radiated measurements above 17 GHz.



RESULTS

NBIoT. BAND 25.

Preliminary measurements determined that 1 tone of 3.75kHz (π/2 – BPSK) as the worst case. The results in the next tables shows the results for this configuration.

1. CHANNEL: LOWEST
Frequency range 30 MHz-1000 MHz.

Spurious frequency (MHz)	Detector	E.I.R.P. (dBm)	Polarization
51.098	Peak	-31.04	V

Frequency range 1 GHz-18 GHz.
No radiated spurious signals were detected at less than 20 dB respect to the limit.

Frequency range 18 GHz-20 GHz.
No radiated spurious signals were detected at less than 20 dB respect to the limit.

2. CHANNEL: MIDDLE
Frequency range 30 MHz-1000 MHz.

Spurious frequency (MHz)	Detector	E.I.R.P. (dBm)	Polarization
51.647	Peak	-31.56	V

Frequency range 1 GHz-18 GHz.
No radiated spurious signals were detected at less than 20 dB respect to the limit.

Frequency range 18 GHz-20 GHz.
No radiated spurious signals were detected at less than 20 dB respect to the limit.

3. CHANNEL: HIGHEST
Frequency range 30 MHz-1000 MHz.

Spurious frequency (MHz)	Detector	E.I.R.P. (dBm)	Polarization
51.647	Peak	-31.87	V

Frequency range 1 GHz-18 GHz.
No radiated spurious signals were detected at less than 20 dB respect to the limit.

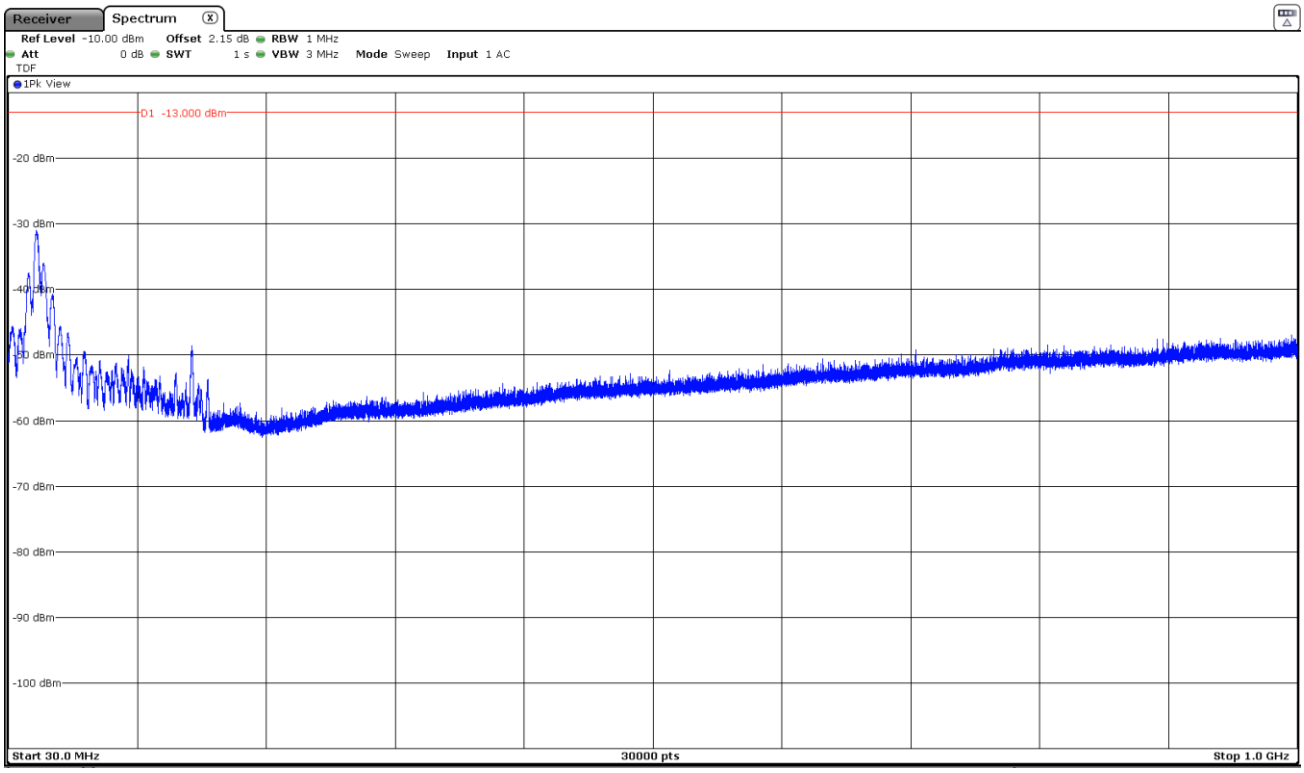
Frequency range 18 GHz-20 GHz.
No radiated spurious signals were detected at less than 20 dB respect to the limit.

Measurement uncertainty (dB)	<±4.65 for f < 1GHz <±3.98 for f ≥ 1 GHz up to 3 GHz <±4.98 for f ≥ 3 GHz up to 17 GHz <±5.33 for f ≥ 17 GHz up to 20 GHz

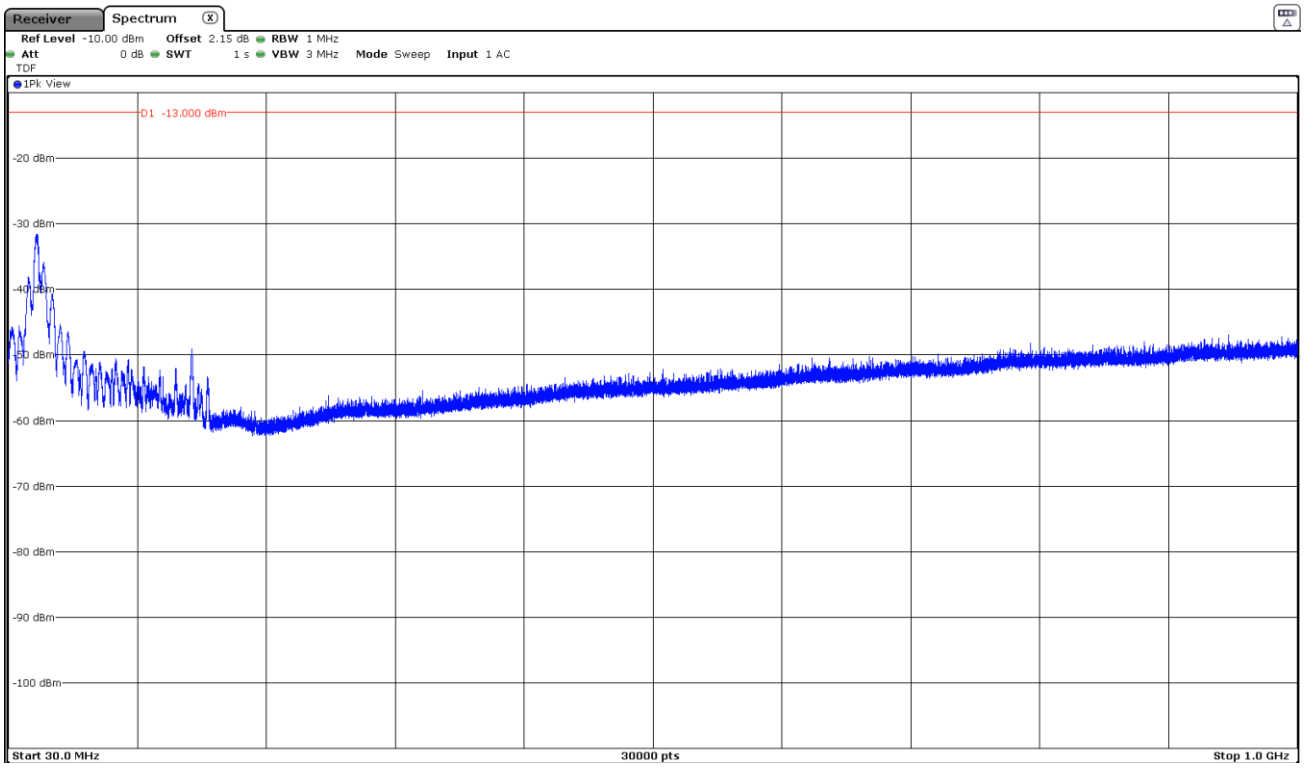
Verdict: PASS

FREQUENCY RANGE 30 MHz-1000 MHz.

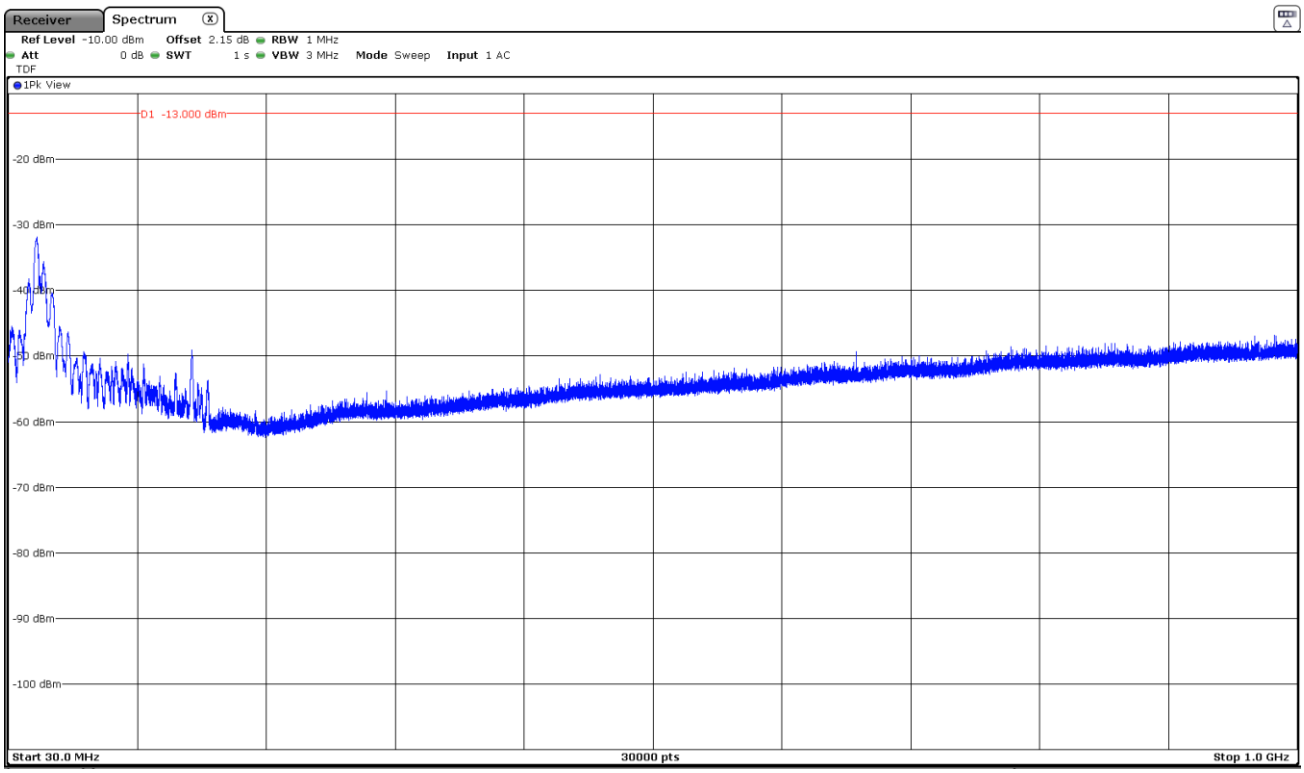
CHANNEL: LOWEST



CHANNEL: MIDDLE

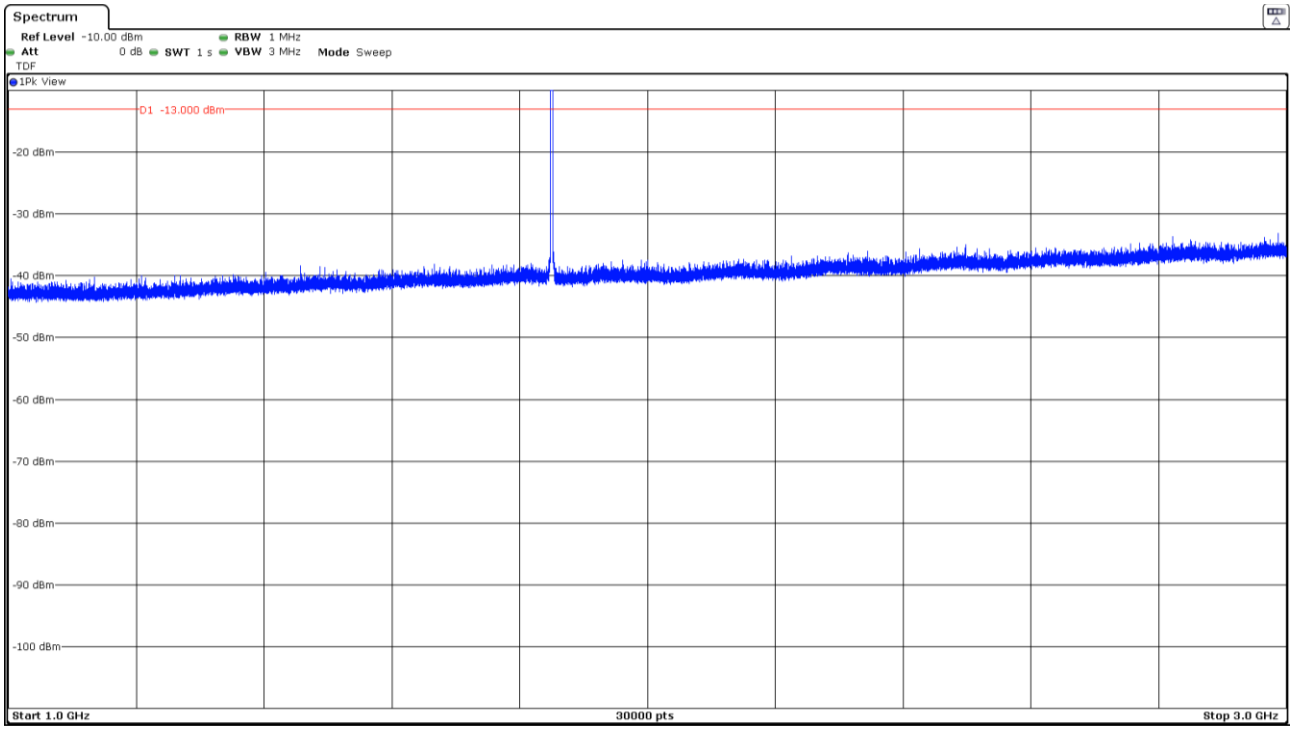


CHANNEL: HIGHEST



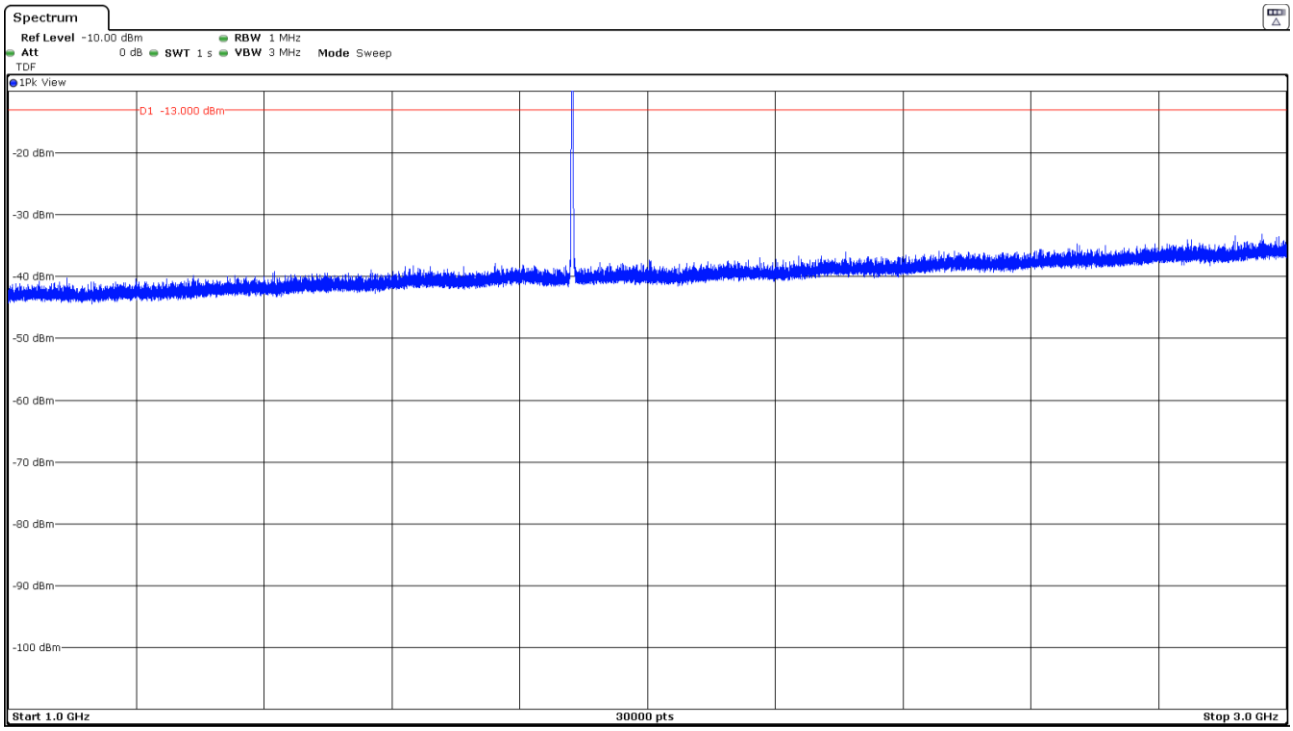
Frequency range 1 GHz to 3 GHz

CHANNEL: LOWEST



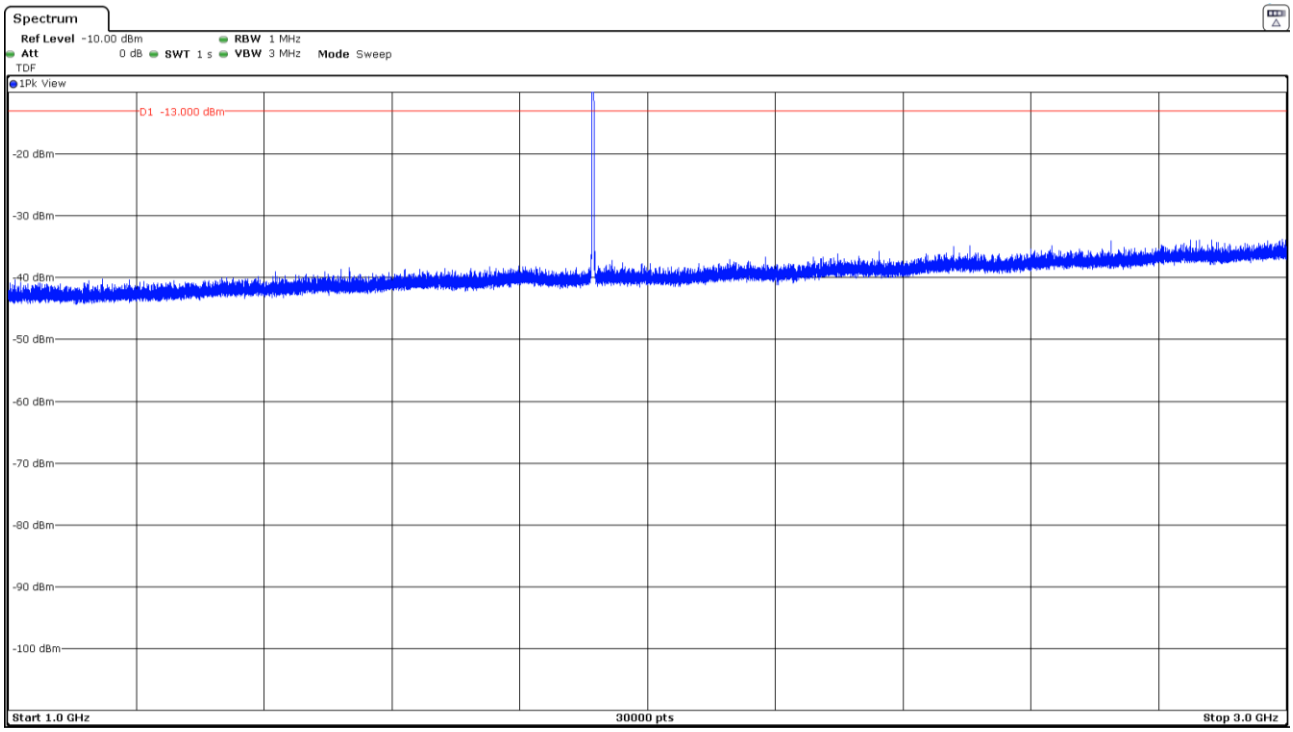
Note: The peak above the limit is the carrier frequency.

CHANNEL: MIDDLE



Note: The peak above the limit is the carrier frequency.

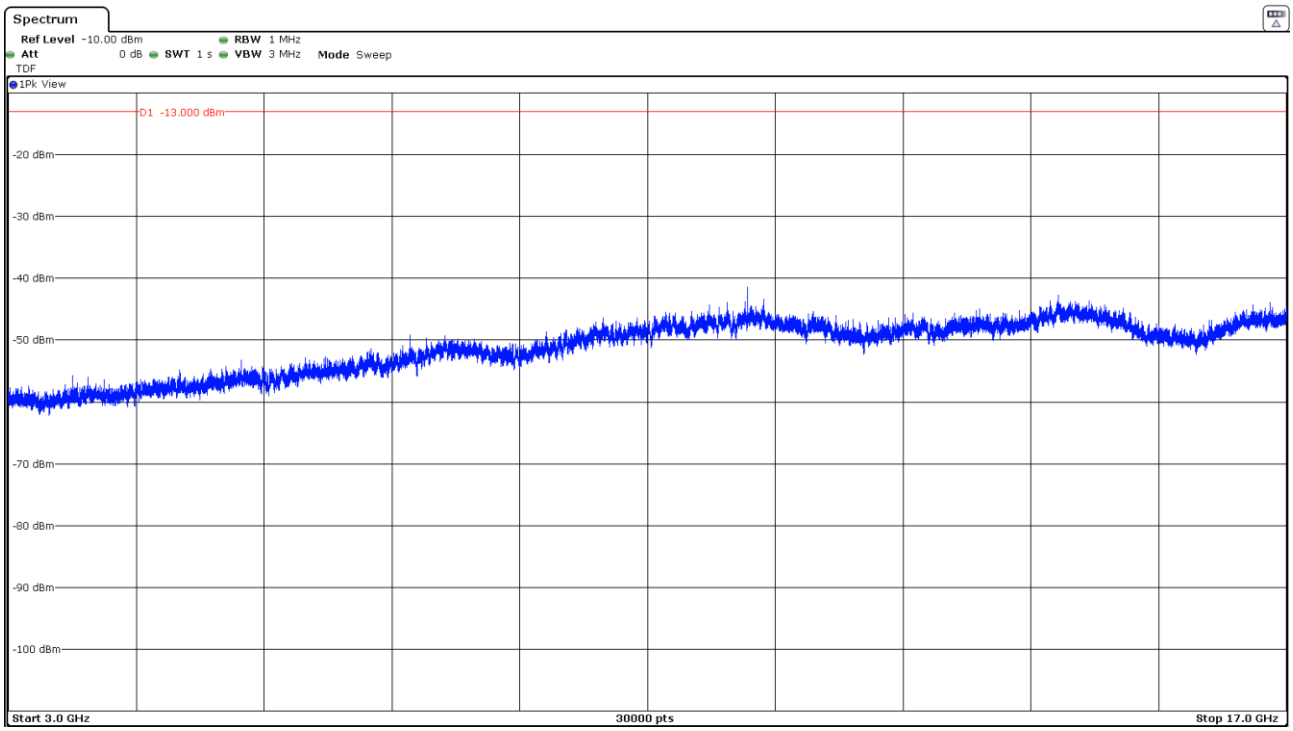
CHANNEL: HIGHEST



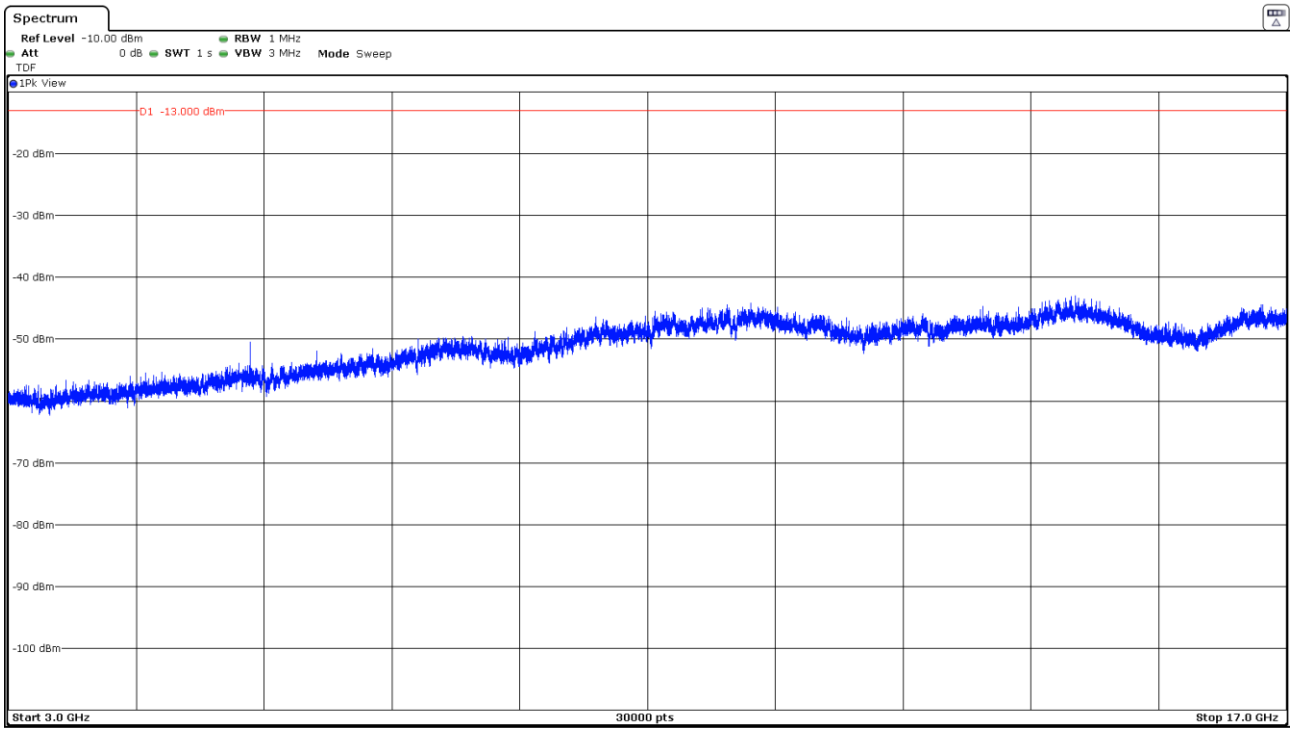
Note: The peak above the limit is the carrier frequency.

Frequency range 3 GHz to 17 GHz

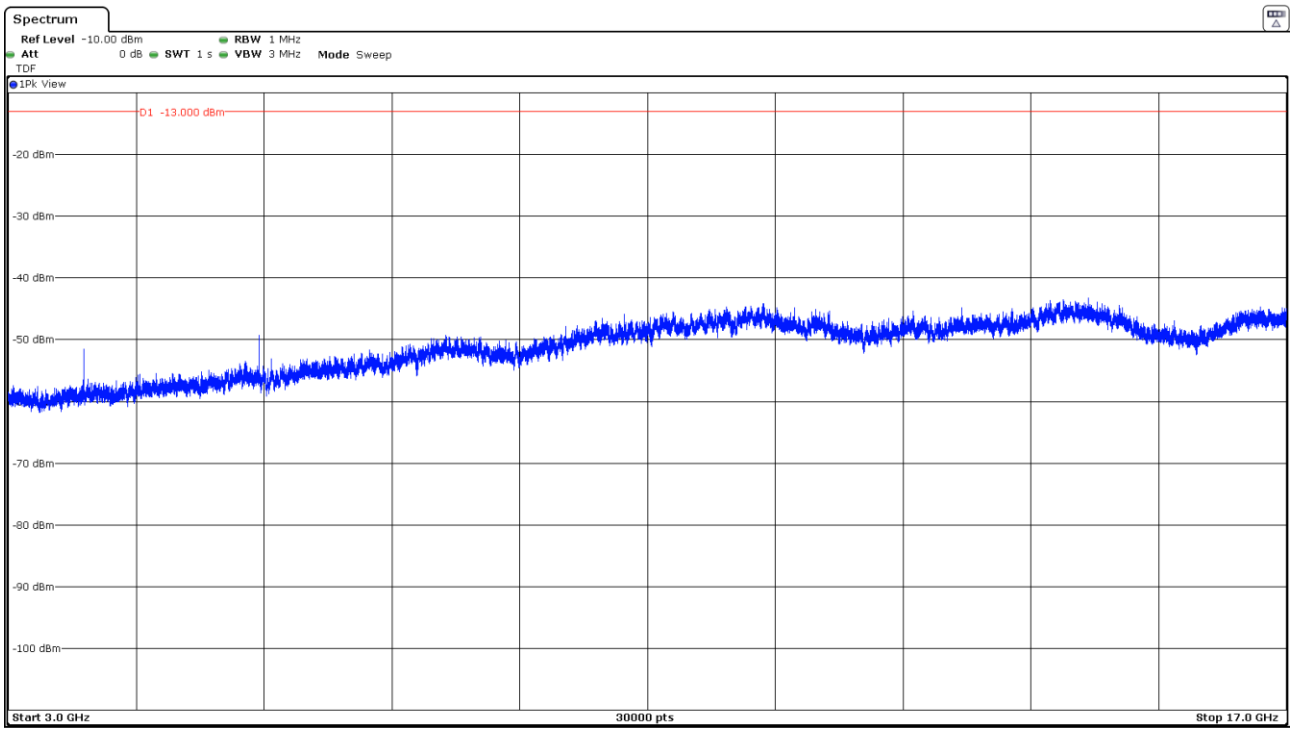
CHANNEL: LOWEST



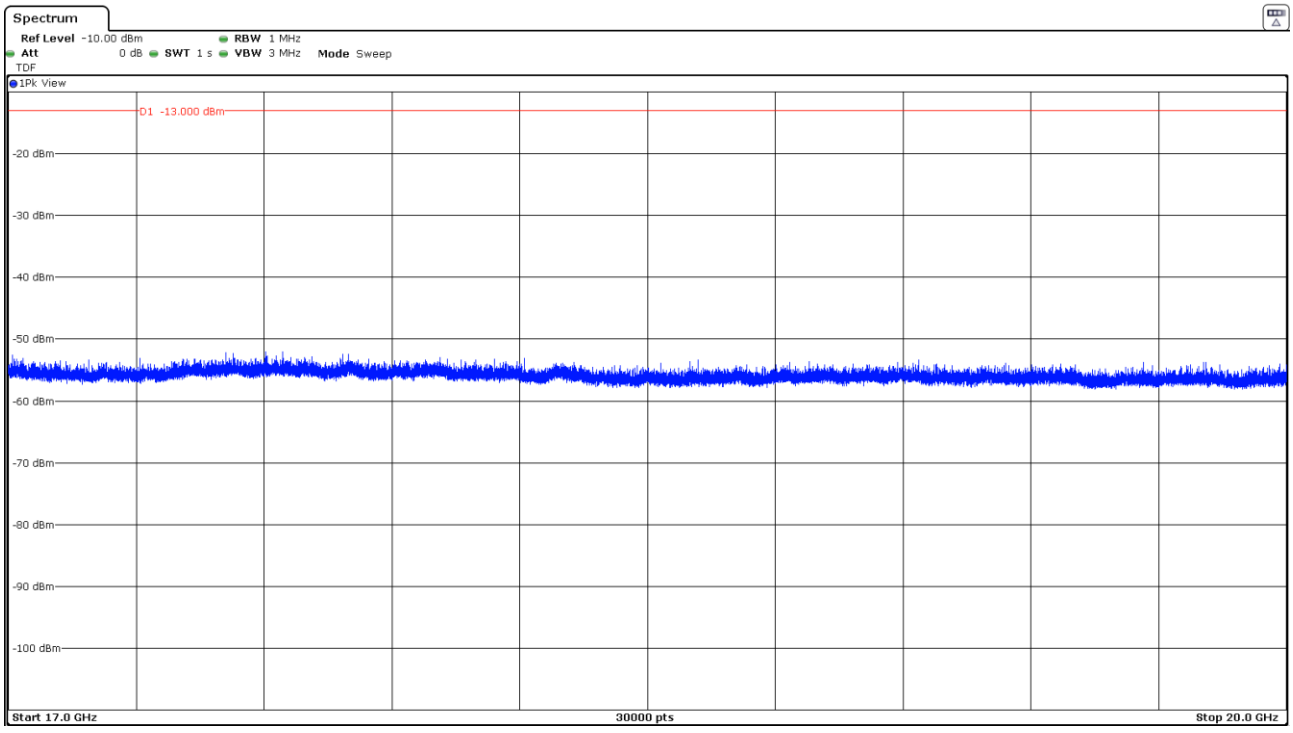
CHANNEL: MIDDLE



CHANNEL: HIGHEST



Frequency range 18 GHz to 20 GHz



(This plot is valid for all three channels)

Appendix B: Test results for FCC Part 27 / RSS-139 / RSS-130

INDEX

TEST CONDITIONS

Power supply (V):

Vnominal = 3.8 Vdc

Type of power supply = DC Voltage from external power supply

Type of antenna = Integral antenna.

Declared Gain for antenna = +2.6 dBi for Band 12 and Band 17 and +4.4 dBi for Band 66

Declared Gain for antenna = +4.4 dBi for Band 4 and +2.6 dBi for Band 13

TEST FREQUENCIES:

NBIoT. π/2 - BPSK AND π/4 - QPSK MODULATION (BAND 4)

Channel (Frequency. MHz)		
Lowest	Middle	Highest
19952 (1710.2)	20175 (1732.5)	20398 (1754.8)

NOTE: Band 4 is completely included in band 66. so the channels of band 66 were tested to give conformity to the assigned block

NBIoT. π/2 - BPSK AND π/4 - QPSK MODULATION (BAND 12)

Channel (Frequency. MHz)		
Lowest	Middle	Highest
23012 (699.2)	23095 (707.5)	23178 (715.8)

NBIoT. π/2 - BPSK AND π/4 - QPSK MODULATION (BAND 13)

Channel (Frequency. MHz)		
Lowest	Middle	Highest
23182 (777.2)	23230 (782)	23278 (786.8)

NBIoT. π/2 - BPSK AND π/4 - QPSK MODULATION (BAND 17)

Channel (Frequency. MHz)		
Lowest	Middle	Highest
23732 (704.2)	23790 (710)	23848 (715.8)

NOTE: Band 17 is completely included in band 12. so the channels of band 12 were tested to give conformity to the assigned block

NBIoT. π/2 - BPSK AND π/4 - QPSK MODULATION (BAND 66)

Channel (Frequency. MHz)		
Lowest	Middle	Highest
131974 (1710.2)	132322 (1745)	132670 (1779.8)

RF Output Power

SPECIFICATION

FCC §27.50 (c) (10).
Portable stations (hand-held devices) in the 600 MHz uplink band and the 698-746 MHz band. and fixed and mobile stations in the 600 MHz uplink band are limited to 3 watts ERP.

FCC §27.50 (b) (10).

Portable stations (hand-held devices) transmitting in the 746-757 MHz. 776-788 MHz. and 805-806 MHz bands are limited to 3 watts ERP.

RSS-130 Clause 4.4.
The e.i.r.p. shall not exceed 50 watts (46.99 dBm) for mobile equipment or for outdoor fixed subscriber equipment nor shall it exceed 5 watts (36.99 dBm) for portable equipment or for indoor fixed subscriber equipment.

FCC §27.50 (d) (4). RSS-139 Clause 6.5.
Fixed. mobile. and portable (hand-held) stations operating in the 1710-1755 MHz band are limited to 1 watt EIRP (30 dBm). Fixed stations operating in the 1710-1755 MHz band are limited to a maximum antenna height of 10 meters above ground. Mobile and portable stations operating in these bands must employ a means for limiting power to the minimum necessary for successful communications.

METHOD

The conducted RF output power measurements were made at the RF output terminals of the EUT using the power meter of the Universal Radio Communication tester R&S CMW500. selecting maximum transmission power of the EUT and different modes of modulation.

The maximum equivalent isotropically radiated power (e.i.r.p.) is calculated by adding the declared maximum antenna gain (dBi).

The maximum effective radiated power e.r.p. is calculated from the maximum equivalent isotropically radiated power (e.i.r.p.) by subtracting 2.15 dB:

$$E.R.P. = E.I.R.P. – 2.15\ dB$$

The EUT was controlled via the Universal Radio Communication tester R&S CMW500 selecting maximum transmission power of the EUT and different modes of modulation.

TEST SETUP

Conducted average power.

RESULTS

MAXIMUM OUTPUT POWER (CONDUCTED).

NBIoT. BAND 12.

Ch	Freq. (MHz)	Modulation	BW (kHz)	Num. tone	Offset Tone	Average Power (dBm)
23012	699.2	π/2 - BPSK	3.75	1	0	22.97
				1	47	22.97
			15	1	0	23.03
				1	11	23.02
		π/4 - QPSK	3.75	1	0	23.00
				1	47	22.95
			15	1	0	23.00
				1	11	23.01
				3	0	22.80
				3	6	22.91
				6	0	22.09
				6	6	22.00
				12	0	21.00
23095	707.5	π/2 - BPSK	3.75	1	0	22.95
				1	47	22.89
			15	1	0	22.99
				1	11	22.96
		π/4 - QPSK	3.75	1	0	22.96
				1	47	22.90
			15	1	0	23.00
				1	11	23.01
				3	0	22.82
				3	6	22.90
				6	0	22.03
				6	6	22.02
				12	0	21.02
23178	715.8	π/2 - BPSK	3.75	1	0	22.95
				1	47	22.91
			15	1	0	22.97
				1	11	22.94
		π/4 - QPSK	3.75	1	0	22.98
				1	47	22.92
			15	1	0	22.97
				1	11	22.97
				3	0	22.81
				3	6	22.90
				6	0	22.01
				6	6	21.96
				12	0	20.91

NBIoT. BAND 13.

Ch	Freq. (MHz)	Modulation	BW (kHz)	Num. tone	Offset Tone	Average Power (dBm)
23182	777.20	π/2 - BPSK	3.75	1	0	23.07
				1	47	23.00
			15	1	0	23.11
				1	11	23.10
		π/4 - QPSK	3.75	1	0	23.07
				1	47	23.01
			15	1	0	23.12
				1	11	23.11
				3	0	22.88
				3	6	22.88
				6	0	22.19
				6	6	22.12
				12	0	21.04
23230	782	π/2 - BPSK	3.75	1	0	22.92
				1	47	22.87
			15	1	0	23.01
				1	11	23.01
		π/4 - QPSK	3.75	1	0	22.95
				1	47	22.89
			15	1	0	23.02
				1	11	22.99
				3	0	22.92
				3	6	22.88
				6	0	22.06
				6	6	22.05
				12	0	21.05
23278	786.8	π/2 - BPSK	3.75	1	0	23.05
				1	47	22.97
			15	1	0	23.10
				1	11	23.11
		π/4 - QPSK	3.75	1	0	23.05
				1	47	22.99
			15	1	0	23.09
				1	11	23.08
				3	0	22.89
				3	6	22.95
				6	0	22.05
				6	6	22.05
				12	0	21.05

NBIoT. BAND 66.

Ch	Freq. (MHz)	Modulation	BW (kHz)	Num. tone	Offset Tone	Average Power (dBm)
131974	1710.2	π/2 - BPSK	3.75	1	0	23.23
				1	47	23.18
			15	1	0	23.21
				1	11	23.22
		π/4 - QPSK	3.75	1	0	23.14
				1	47	23.20
			15	1	0	23.19
				1	11	23.16
				3	0	23.03
				3	6	23.04
				6	0	22.24
				6	6	22.13
				12	0	21.20
132322	1745	π/2 - BPSK	3.75	1	0	23.16
				1	47	23.10
			15	1	0	23.24
				1	11	23.25
		π/4 - QPSK	3.75	1	0	23.18
				1	47	23.11
			15	1	0	23.21
				1	11	23.24
				3	0	22.99
				3	6	23.00
				6	0	22.26
				6	6	22.20
				12	0	21.16
132670	1779.8	π/2 - BPSK	3.75	1	0	23.15
				1	47	23.07
			15	1	0	23.20
				1	11	23.21
		π/4 - QPSK	3.75	1	0	23.15
				1	47	23.09
			15	1	0	23.22
				1	11	23.23
				3	0	23.10
				3	6	23.11
				6	0	22.25
				6	6	22.18
				12	0	21.20

NBIoT BAND 12.

Channel	Measured maximum average power (dBm) at antenna port	Maximum declared antenna gain (dBi)	Maximum equivalent isotropically radiated power (E.I.R.P.) (dBm)	Maximum effective radiated power E.R.P. (dBm)
Lowest	23.03	+2.6	25.63	23.48
Middle	23.01	+2.6	25.61	23.46
Highest	22.98	+2.6	25.58	23.43
Measurement uncertainty (dB)	<±1.58			

NBIoT BAND 13.

Channel	Measured maximum average power (dBm) at antenna port	Maximum declared antenna gain (dBi)	Maximum equivalent isotropically radiated power (E.I.R.P.) (dBm)	Maximum effective radiated power E.R.P. (dBm)
Lowest	23.12	+2.6	25.72	23.57
Middle	23.02	+2.6	25.62	23.47
Highest	23.11	+2.6	25.71	23.56
Measurement uncertainty (dB)	<±1.58			

NBIoT BAND 66.

Channel	Measured maximum average power (dBm) at antenna port	Maximum declared antenna gain (dBi)	Maximum equivalent isotropically radiated power (E.I.R.P.) (dBm)	Maximum effective radiated power E.R.P. (dBm)
Lowest	23.23	+4.4	27.63	25.48
Middle	23.25	+4.4	27.65	25.50
Highest	23.23	+4.4	27.63	25.48
Measurement uncertainty (dB)	<±1.58			

Verdict: PASS

GEN2 AND GEN1 OUTPUT POWER COMPARISON (CONDUCTED).

LTE. BAND 12.

The results in the next table shows the maximum difference between GEN2 and GEN1 devices for conducted output power measurements.

Maximum conducted output power difference between GEN2 and GEN1 (dB)	0.14

Measurement uncertainty (dB)	<±1.58

LTE. BAND 13.

The results in the next table shows the maximum difference between GEN2 and GEN1 devices for conducted output power measurements.

Maximum conducted output power difference between GEN2 and GEN1 (dB)	0.37

Measurement uncertainty (dB)	<±1.58

LTE. BAND 66.

The results in the next table shows the maximum difference between GEN2 and GEN1 devices for conducted output power measurements.

Maximum conducted output power difference between GEN2 and GEN1 (dB)	0.50

Measurement uncertainty (dB)	<±1.58

Radiated emissions

SPECIFICATION

FCC §27.53 (g).

For operations in the 600 MHz band and the 698-746 MHz band. the power of any emission outside a licensee's frequency band(s) of operation shall be attenuated below the transmitter power (P) within the licensed band(s) of operation. measured in watts. by at least 43 + 10 log (P) dB. Compliance with this provision is based on the use of measurement instrumentation employing a resolution bandwidth of 100 kilohertz or greater. However. in the 100 kilohertz bands immediately outside and adjacent to a licensee's frequency block. a resolution bandwidth of at least 30 kHz may be employed

FCC §27.53 (c) & (f).
On any frequency outside the 776-788 MHz band. the power of any emission shall be attenuated outside the band below the transmitter power (P) by at least 43 + 10 log (P) dB.

On all frequencies between 763-775 MHz and 793-805 MHz. by a factor not less than 65 + 10 log (P) dB in a 6.25 kHz band segment. for mobile and portable stations.

For operations in the 746-758 MHz. 775-788 MHz. and 805-806 MHz bands. emissions in the band 1559-1610 MHz shall be limited to −70 dBW (-40 dBm)/MHz equivalent isotropically radiated power (EIRP) for wideband signals. and −80 dBW (-50 dBm) EIRP for discrete emissions of less than 700 Hz bandwidth.

RSS-130 Clause 4.6.
The power of any unwanted emissions in any 100 kHz bandwidth on any frequency outside the frequency range(s) within which the equipment is designed to operate shall be attenuated below the transmitter power. P (dBW). by at least 43 + 10 log10 p (watts). dB.

The power of any unwanted emissions in any 6.25 kHz bandwidth for all frequencies between 763-775 MHz and 793-806 MHz shall be attenuated below the transmitter power. P (dBW). by at least 65 + 10 log10 p(watts). dB. for mobile and portable equipment.

The e.i.r.p. in the band 1559-1610 MHz shall not exceed -70 dBW (-40 dBm) /MHz for wideband signal and -80 dBW (-50 dBm) for discrete emission with bandwidth less than 700 Hz.

FCC §27.53 (h). RSS-139 Clause 6.6.
According to specification. the power of emissions shall be attenuated below the transmitter power (P) by a factor of at least 43 + 10 log (P) dB. P in watts.

At Po transmitting power. the specified minimum attenuation becomes 43+10 log (Po). and the level in dBm relative Po becomes:
Po (dBm) – [43 + 10 log (Po in mwatts) - 30] = -13 dBm.

METHOD

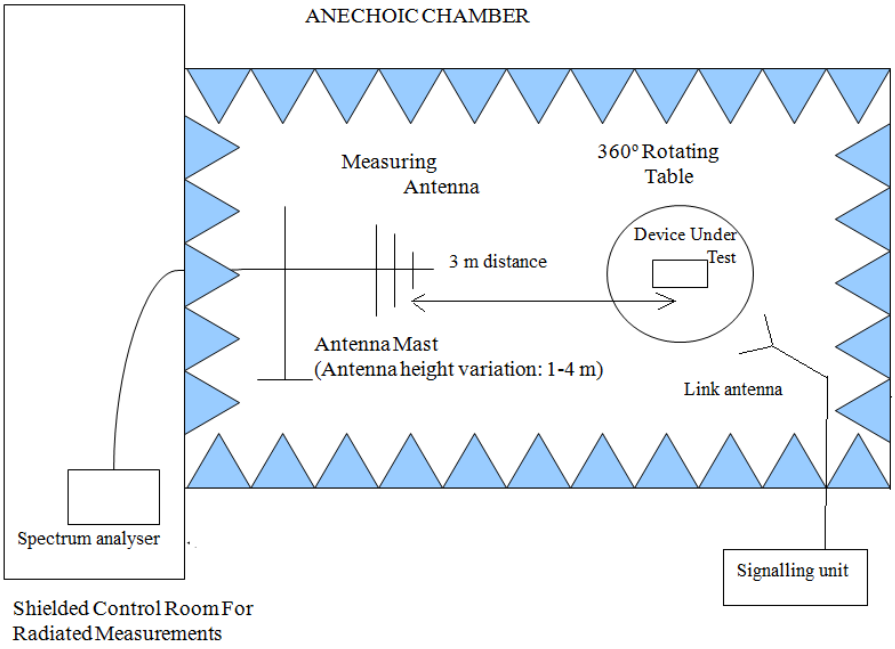
The measurement was performed with the EUT inside an anechoic chamber. The spectrum was scanned from 30 MHz to at least the 10th harmonic of the highest frequency generated within the equipment.
The EUT was placed on a non-conductive stand at a 3 meter distance from the measuring antenna for measurements below 1 GHz and at 1 m distance for measurements above 1 GHz.
Detected emissions were maximized at each frequency by rotating the EUT and adjusting the measuring antenna height and polarization. The maximum field strength (dBµV/m) is measured and recorded.

The maximum field strength (dBµV/m) of each detected emission at less than 20 dB respect to the limit is converted to an equivalent EIRP level (dBm) according to ANSI C63.26 with the formula:

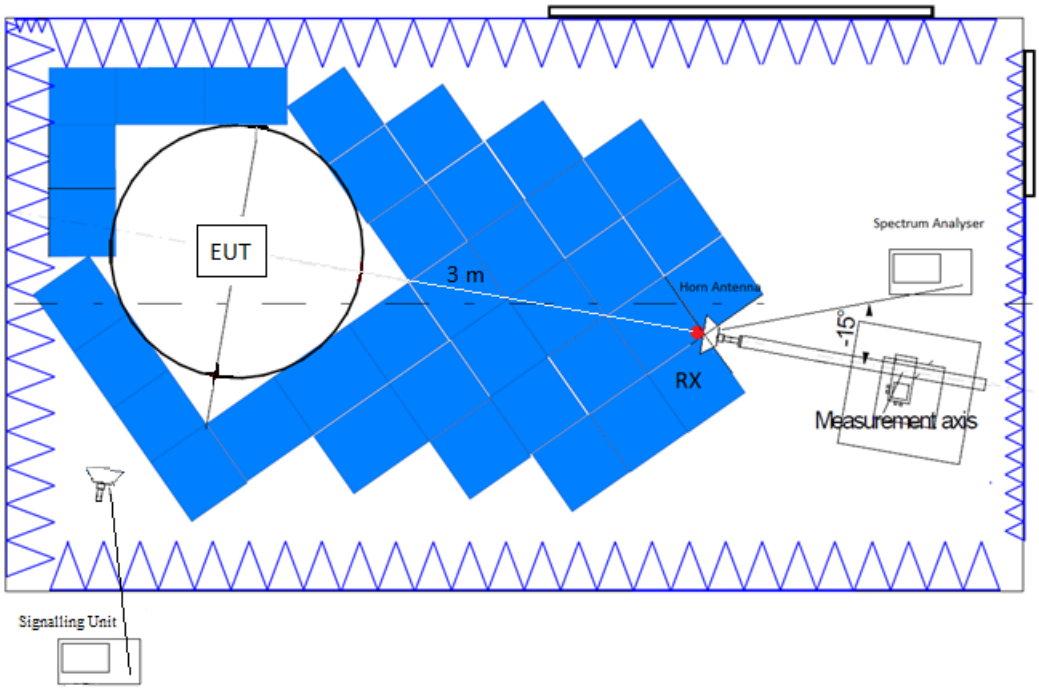
EIRP (dBm) = E (dBµV/m) + 20log(D) - 104.8; where D is the measurement distance (in the far field region) in m. D = 3 m

TEST SETUP

Radiated measurements below 1 GHz.



Radiated measurements above 1 GHz.



RESULTS

NBIoT. BAND 12.

Preliminary measurements determined that 1 tone of 15kHz (π/2 – BPSK) as the worst case. The results in the next tables shows the results for this configuration.

1. CHANNEL: LOWEST

Frequency range 30 MHz-1000 MHz.

No radiated spurious signals were detected at less than 20 dB respect to the limit.

Frequency range 1 GHz-8 GHz.

No radiated spurious signals were detected at less than 20 dB respect to the limit.

2. CHANNEL: MIDDLE

Frequency range 30 MHz-1000 MHz.

No radiated spurious signals were detected.

Frequency range 1 GHz-8 GHz.

No radiated spurious signals were detected at less than 20 dB respect to the limit.

3. CHANNEL: HIGHEST

Frequency range 30 MHz-1000 MHz.

No radiated spurious signals were detected.

Frequency range 1 GHz-8 GHz.

No radiated spurious signals were detected at less than 20 dB respect to the limit.

Measurement uncertainty (dB)	<±4.65 for f < 1GHz <±4.98 for f ≥ 1 GHz up to 8 GHz

Verdict: PASS

NBIoT. BAND 13.

Preliminary measurements determined that 1 tone of 15kHz (π/2 – BPSK) as the worst case. The results in the next tables shows the results for this configuration.

1. CHANNEL: LOWEST

Frequency range 30 MHz-1000 MHz.

No radiated spurious signals were detected at less than 20 dB respect to the limit.

Frequency range 1 GHz-8 GHz.

No radiated spurious signals were detected at less than 20 dB respect to the limit.

Frequency range 1559 MHz-1610 MHz.

Spurious frequency (MHz)	Detector	E.I.R.P. (dBm)	Polarization
1.6000	Peak	-59.76	H

2. CHANNEL: MIDDLE

Frequency range 30 MHz-1000 MHz.

No radiated spurious signals were detected.

Frequency range 1 GHz-8 GHz.
No radiated spurious signals were detected at less than 20 dB respect to the limit.

Frequency range 1559 MHz-1610 MHz.

Spurious frequency (MHz)	Detector	E.I.R.P. (dBm)	Polarization
1.56394	Peak	-55.16	H

3. CHANNEL: HIGHEST

Frequency range 30 MHz-1000 MHz.

No radiated spurious signals were detected.

Frequency range 1 GHz-8 GHz.

No radiated spurious signals were detected at less than 20 dB respect to the limit.

Frequency range 1559 MHz-1610 MHz.

Spurious frequency (MHz)	Detector	E.I.R.P. (dBm)	Polarization
1.57362	Peak	-53.23	H

Measurement uncertainty (dB)	<±4.65 for f < 1GHz <±4.98 for f ≥ 1 GHz up to 8 GHz

Verdict: PASS

NBIoT. BAND 66.

Preliminary measurements determined that 3 tones of 15kHz as the worst case. The results in the next tables shows the results for this configuration.

1. CHANNEL: LOWEST
Frequency range 30 MHz-1000 MHz.

Spurious frequency (MHz)	Detector	E.I.R.P. (dBm)	Polarization
51.583	Peak	-31.18	V

Frequency range 1 GHz-18 GHz.

No radiated spurious signals were detected at less than 20 dB respect to the limit.

2. CHANNEL: MIDDLE
Frequency range 30 MHz-1000 MHz.

Spurious frequency (MHz)	Detector	E.I.R.P. (dBm)	Polarization
51.098	Peak	-31.39	V

Frequency range 1 GHz-18 GHz.

No radiated spurious signals were detected at less than 20 dB respect to the limit.

3. CHANNEL: HIGHEST
Frequency range 30 MHz-1000 MHz.

Spurious frequency (MHz)	Detector	E.I.R.P. (dBm)	Polarization
51.777	Peak	-31.23	V

Frequency range 1 GHz-18 GHz.

No radiated spurious signals were detected at less than 20 dB respect to the limit.

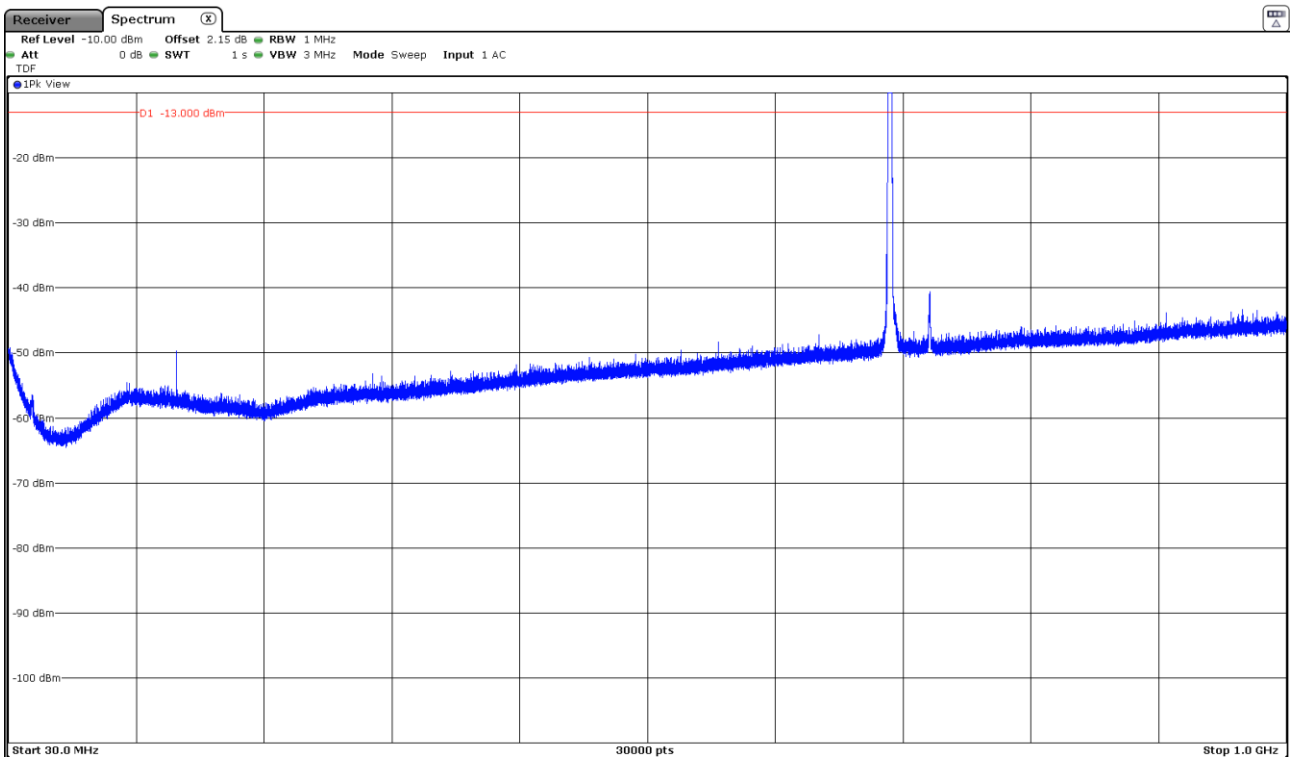
Measurement uncertainty (dB)	<±4.65 for f < 1GHz <±3.98 for f ≥ 1 GHz up to 3 GHz <±4.98 for f ≥ 3 GHz up to 18 GHz

Verdict: PASS

NBIoT Band 12

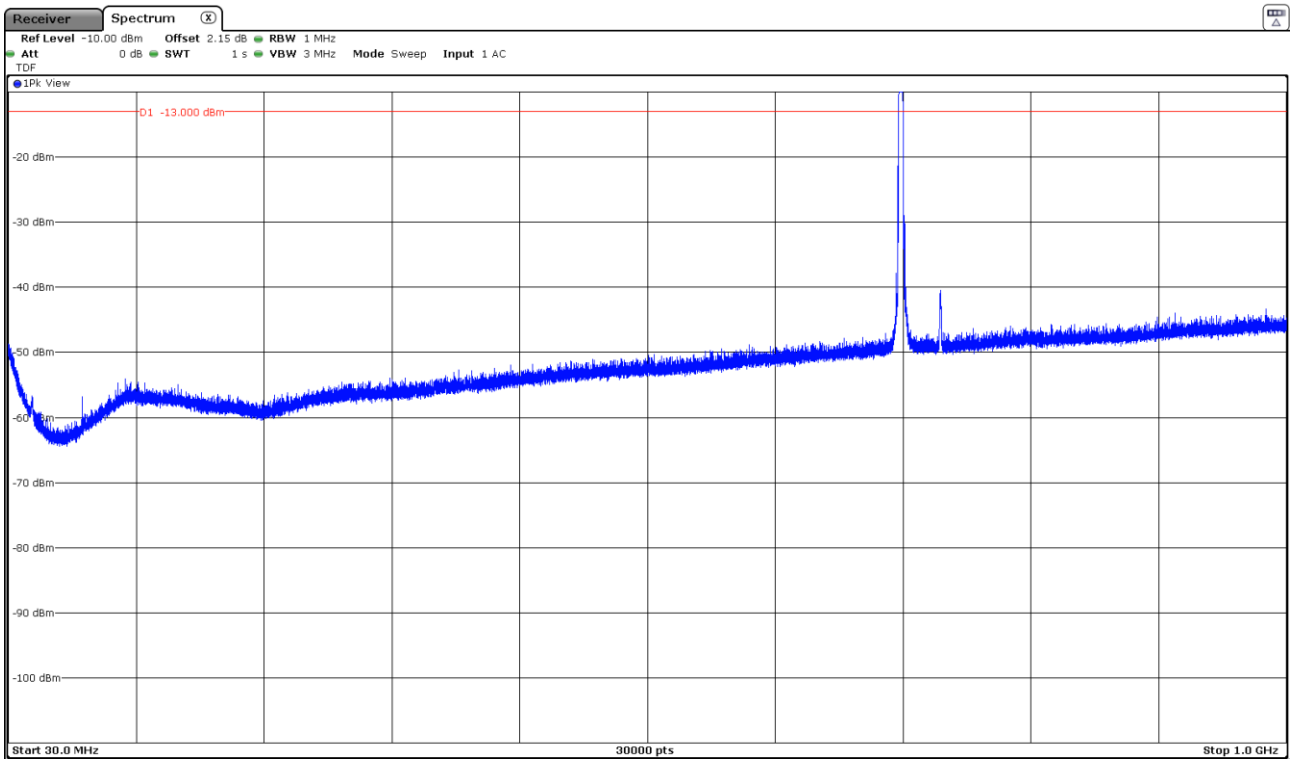
Frequency range 30 MHz to 1 GHz

CHANNEL: LOWEST



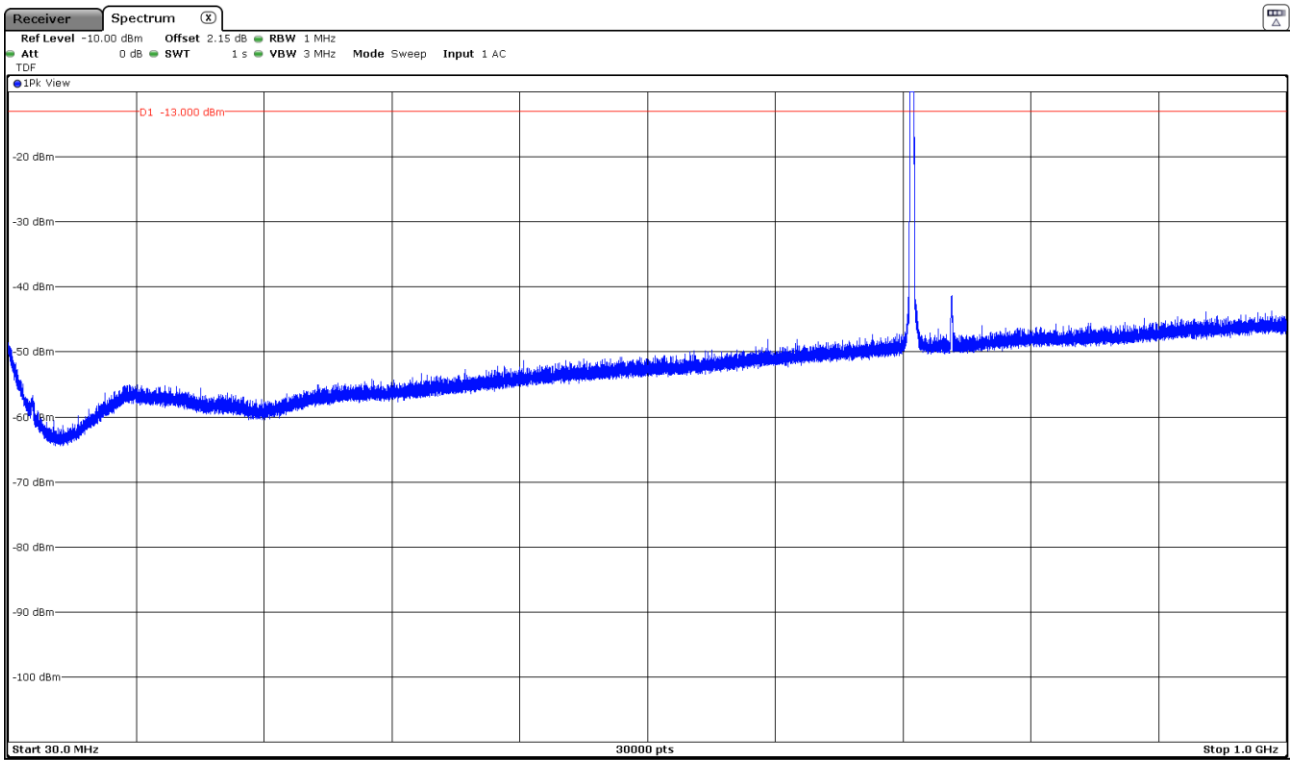
Note: The peak above the limit is the carrier frequency. The peak at 729MHz corresponds to the downlink signal

CHANNEL: MIDDLE



Note: The peak above the limit is the carrier frequency. The peak at 737MHz corresponds to the downlink signal.

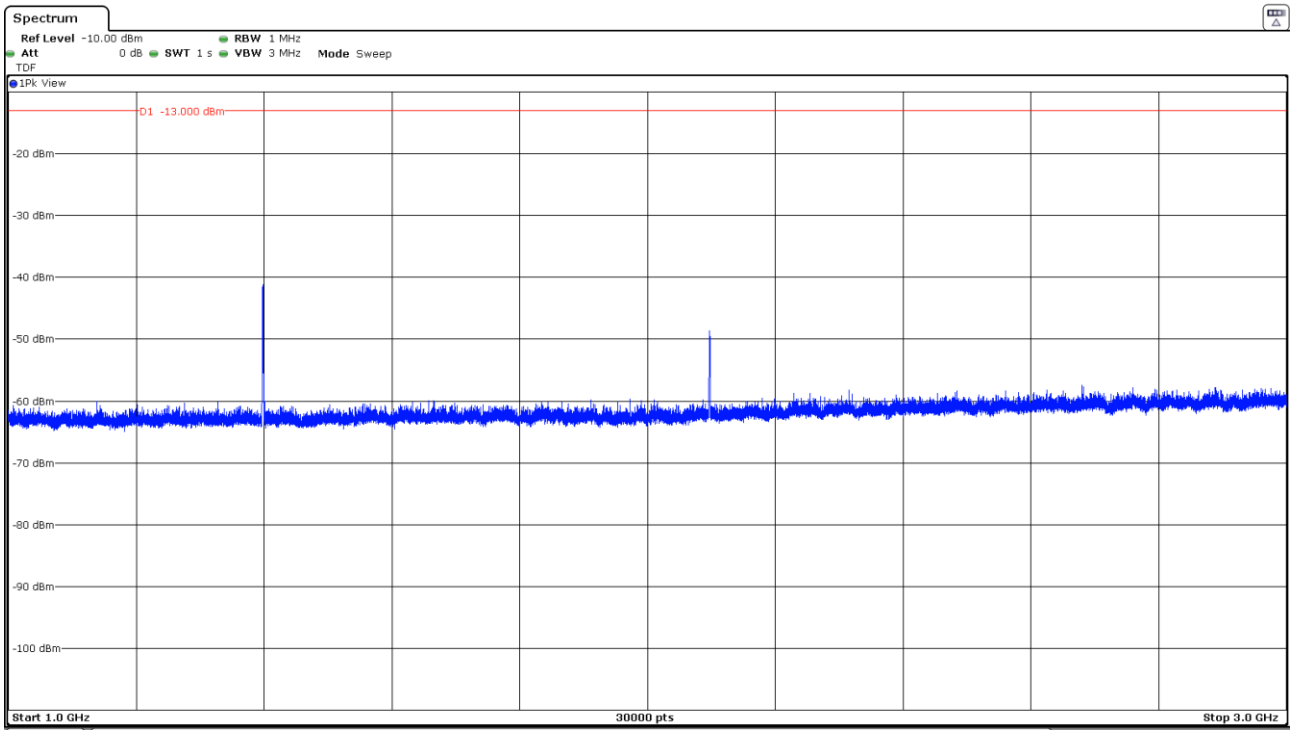
CHANNEL: HIGHEST



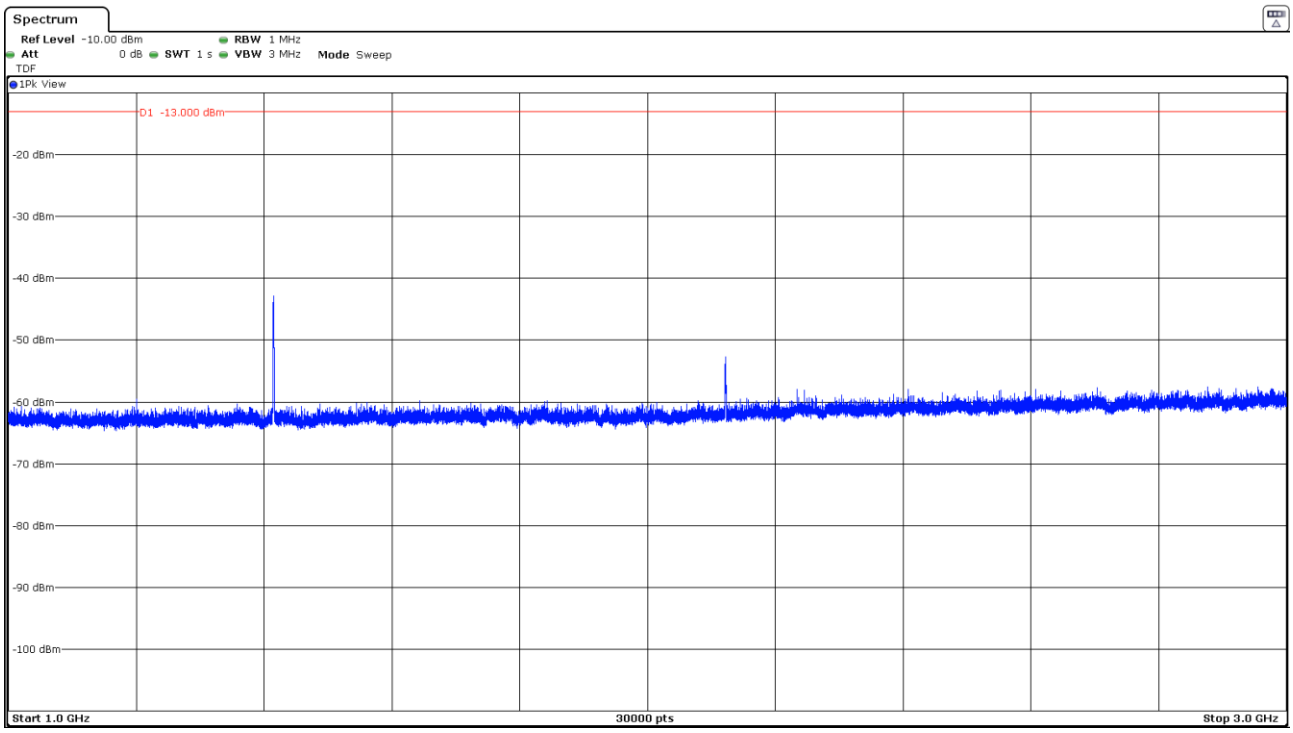
Note: The peak above the limit is the carrier frequency. The peak at 746MHz corresponds to the downlink signal.

Frequency range 1 GHz to 3 GHz

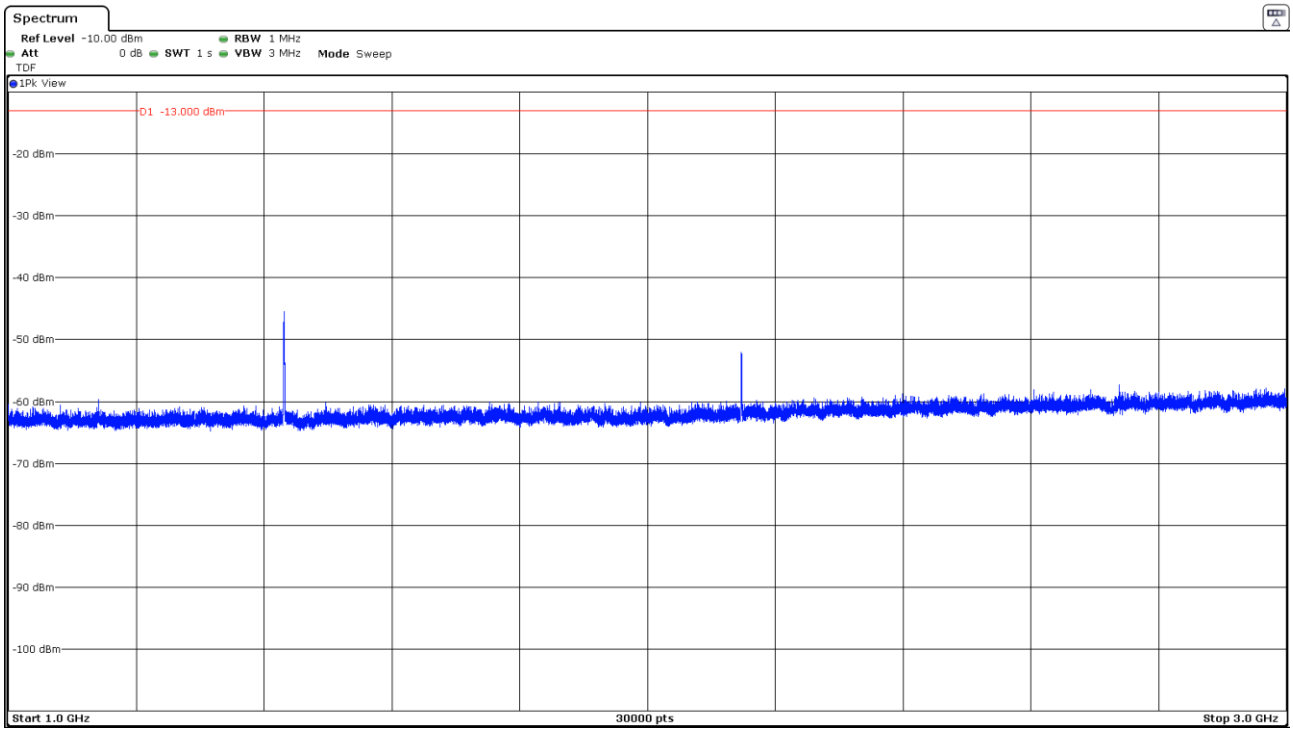
CHANNEL: LOWEST



CHANNEL: MIDDLE

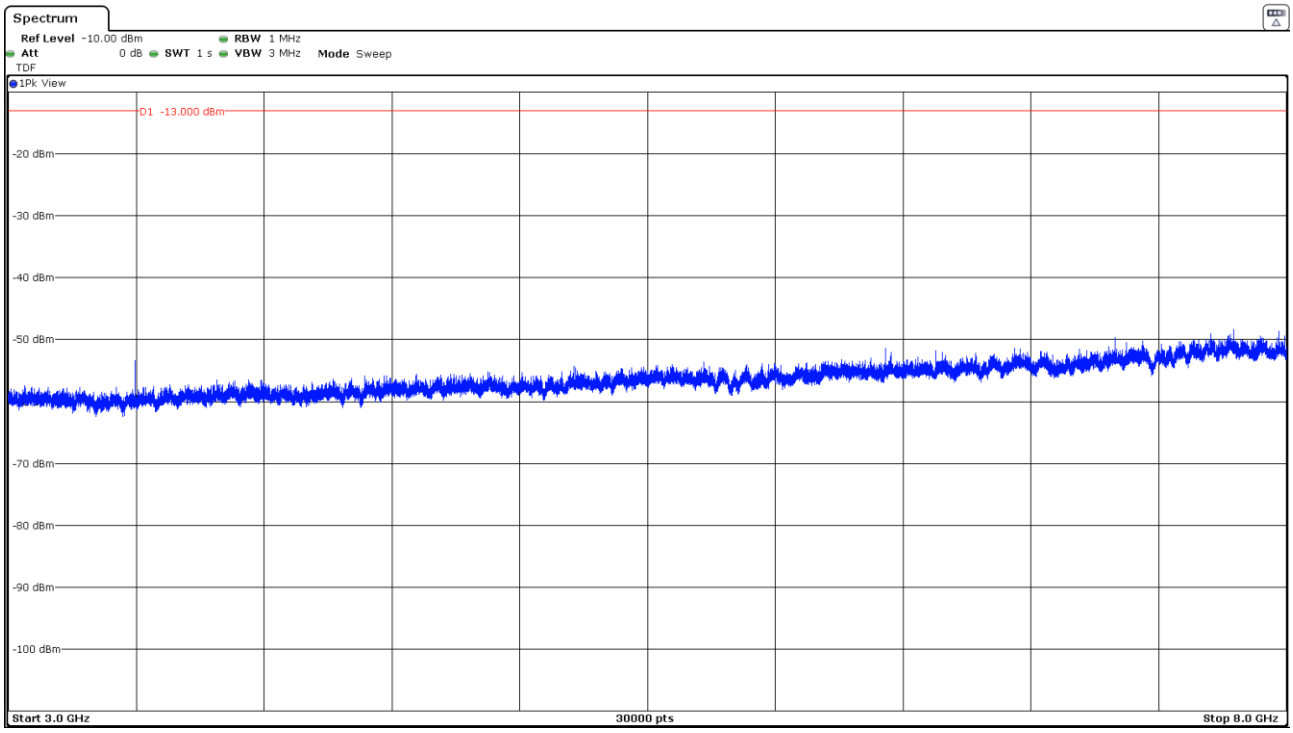


CHANNEL: HIGHEST

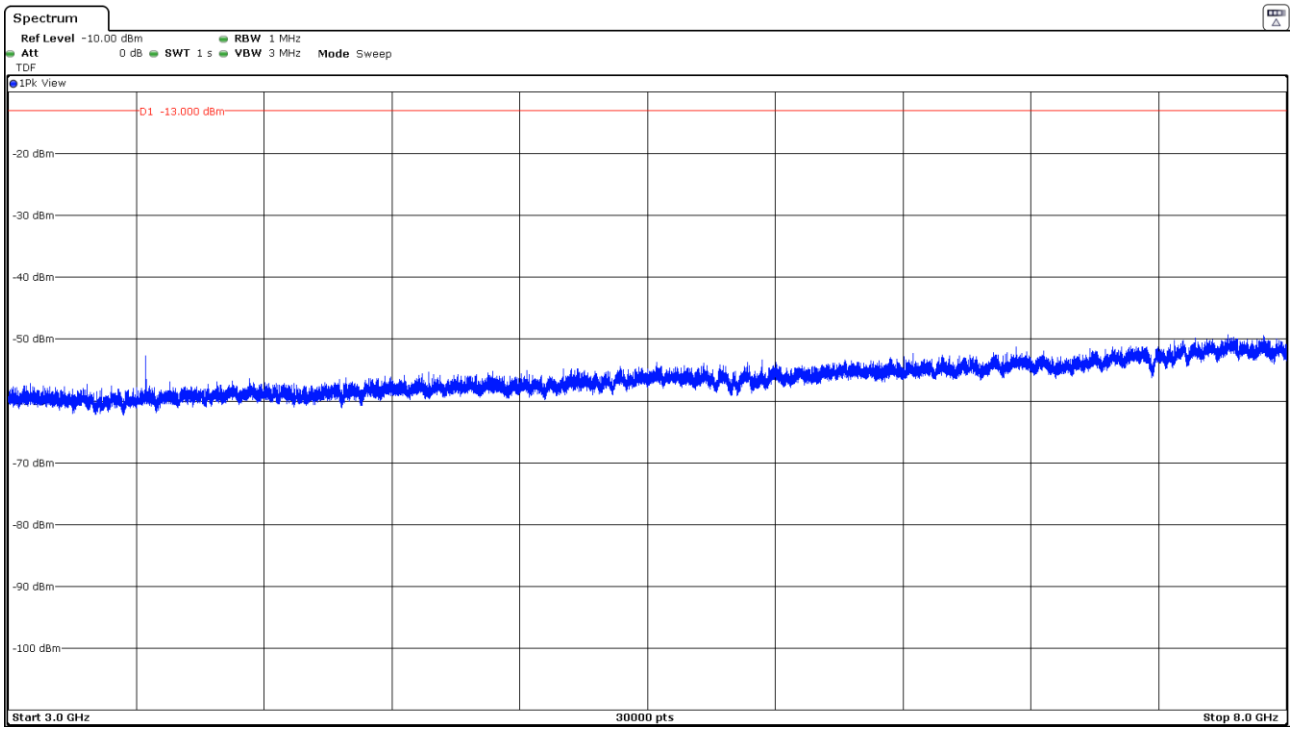


Frequency range 3 GHz to 8 GHz

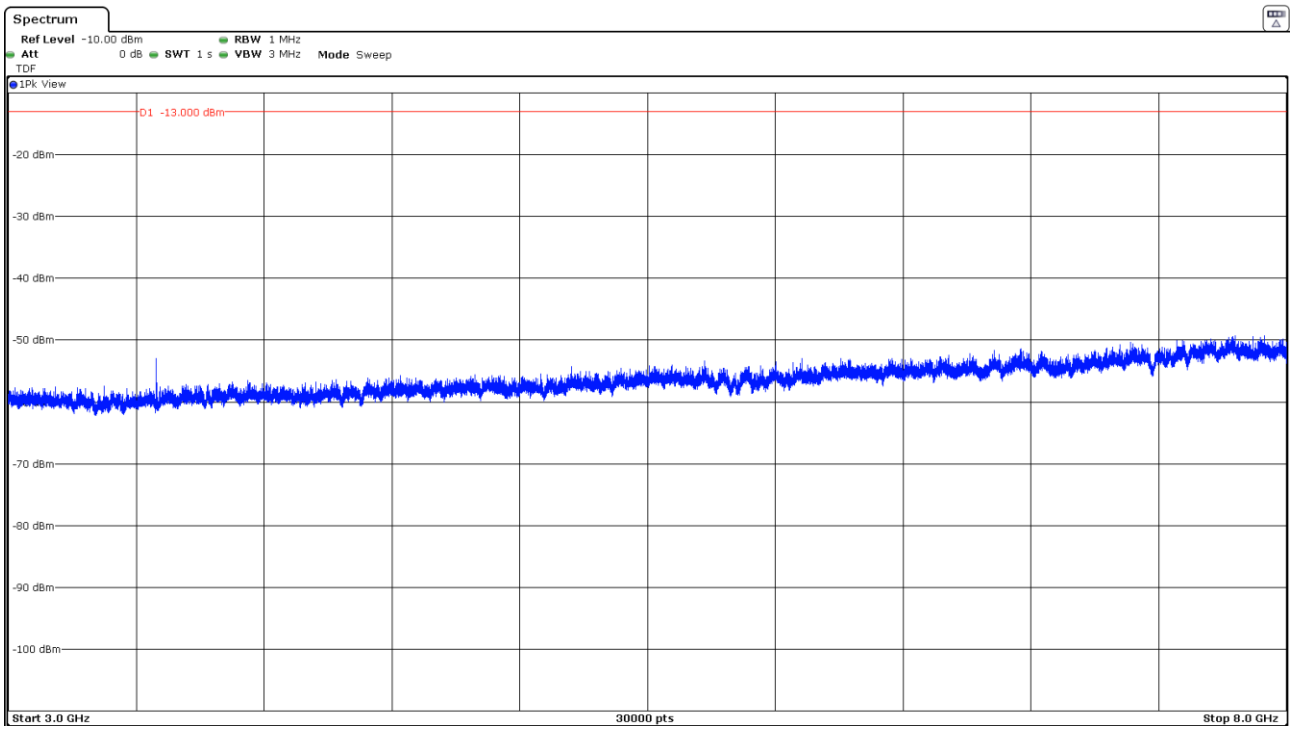
CHANNEL: LOWEST



CHANNEL: MIDDLE



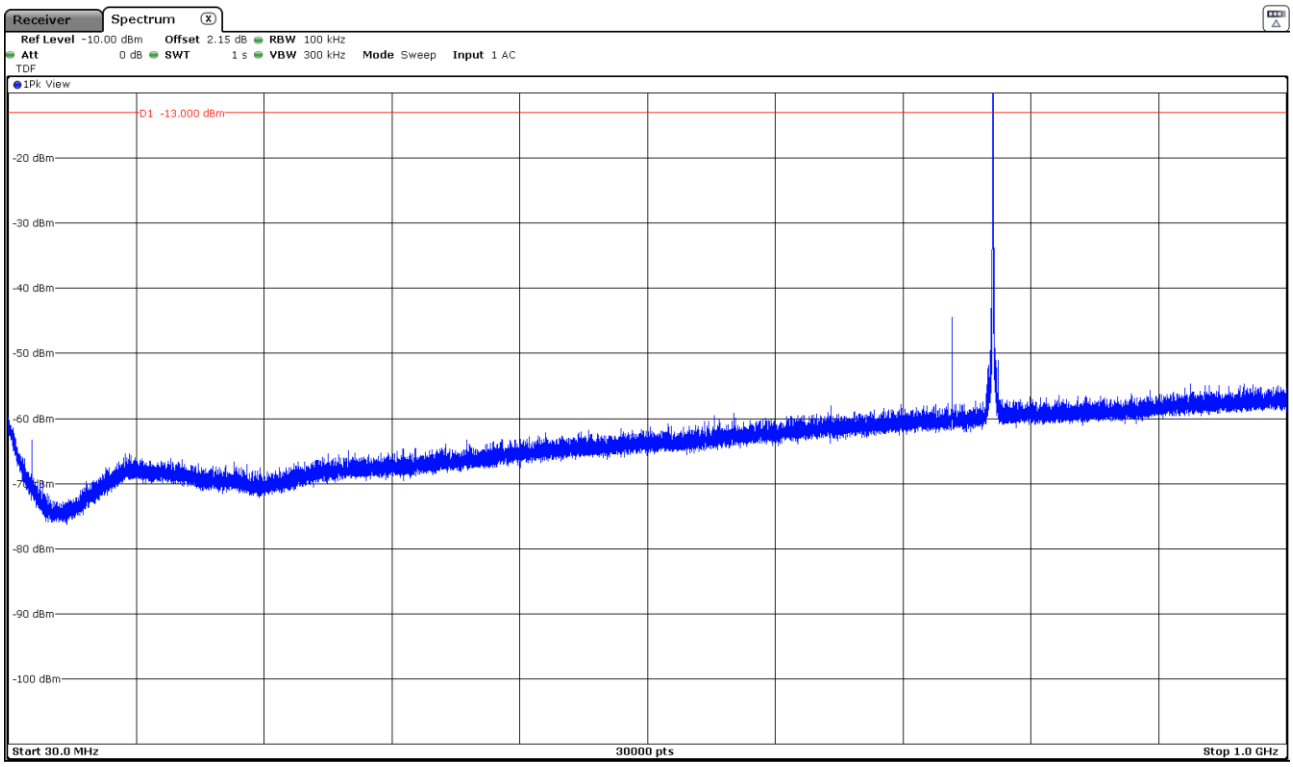
CHANNEL: HIGHEST



NBIoT Band 13

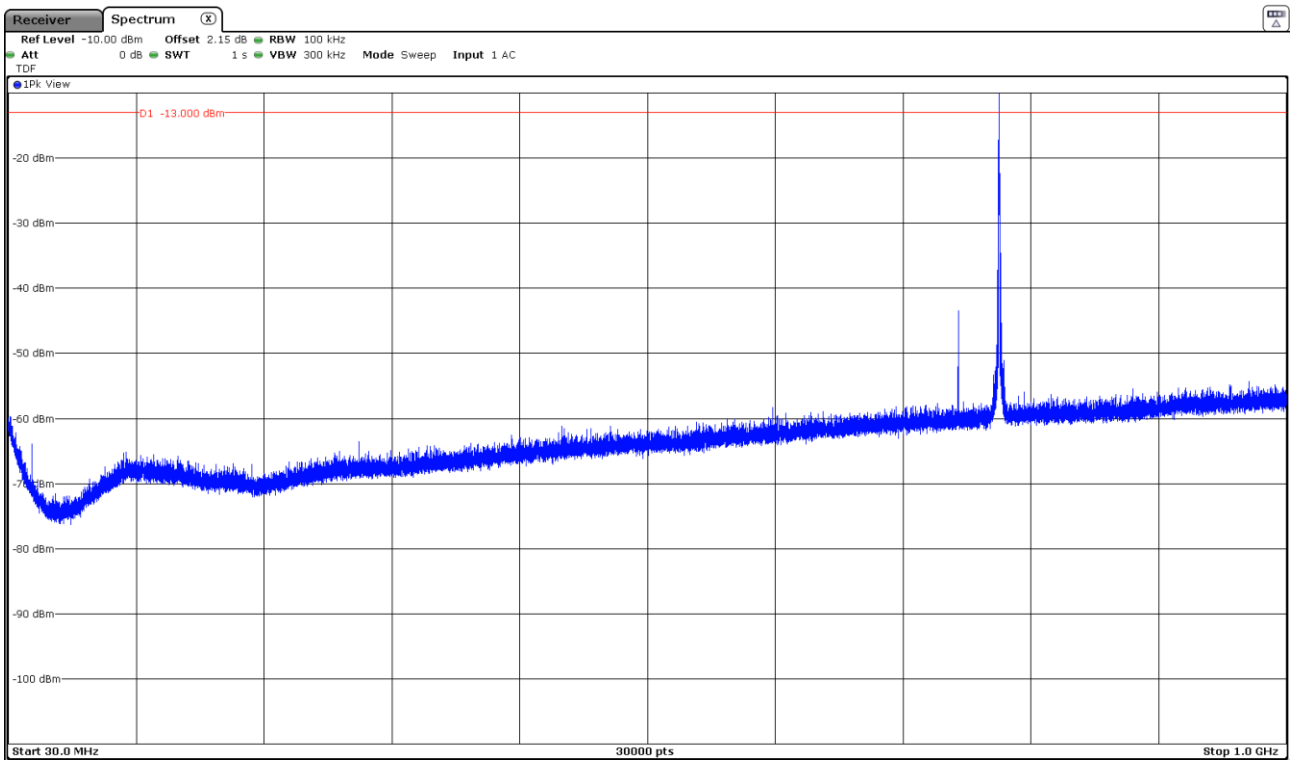
Frequency range 30 MHz to 1 GHz

CHANNEL: LOWEST



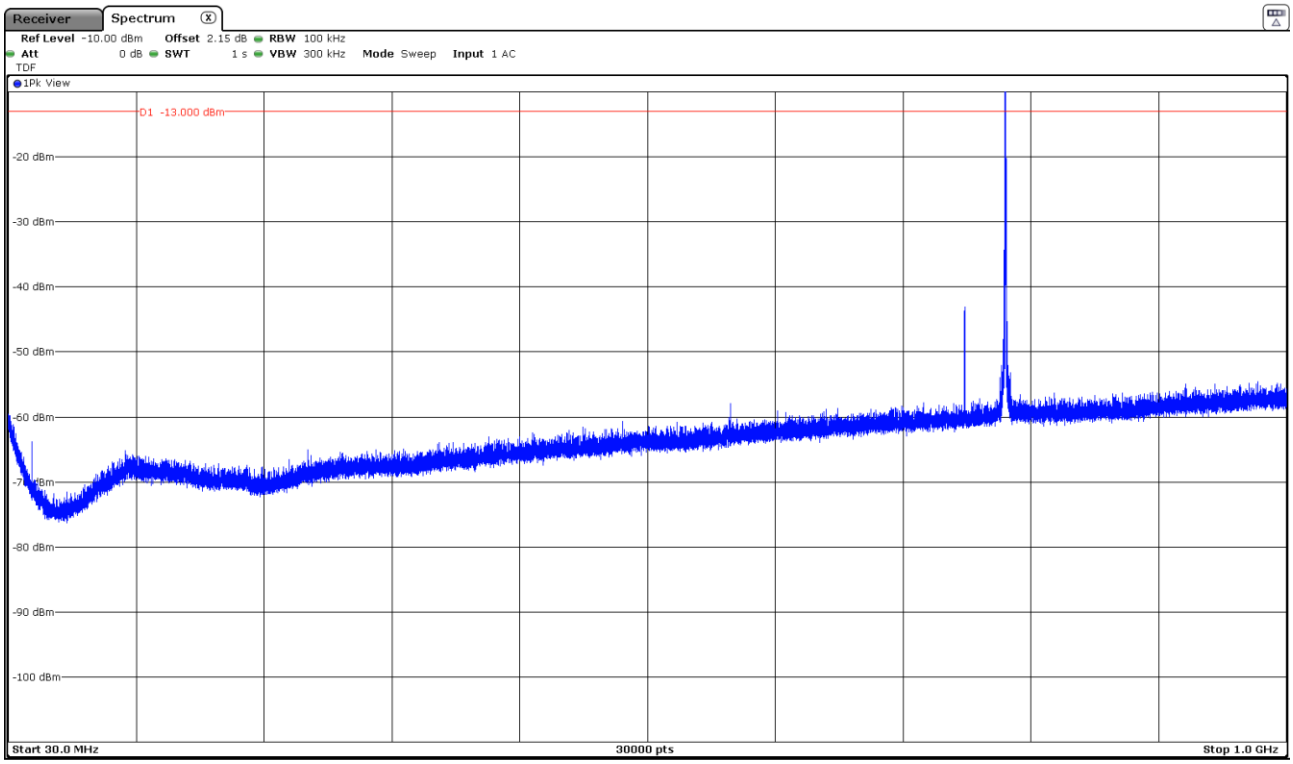
Note: The peak above the limit is the carrier frequency. The peak at 746MHz corresponds to the downlink signal.

CHANNEL: MIDDLE



Note: The peak above the limit is the carrier frequency. The peak at 751MHz corresponds to the downlink signal.

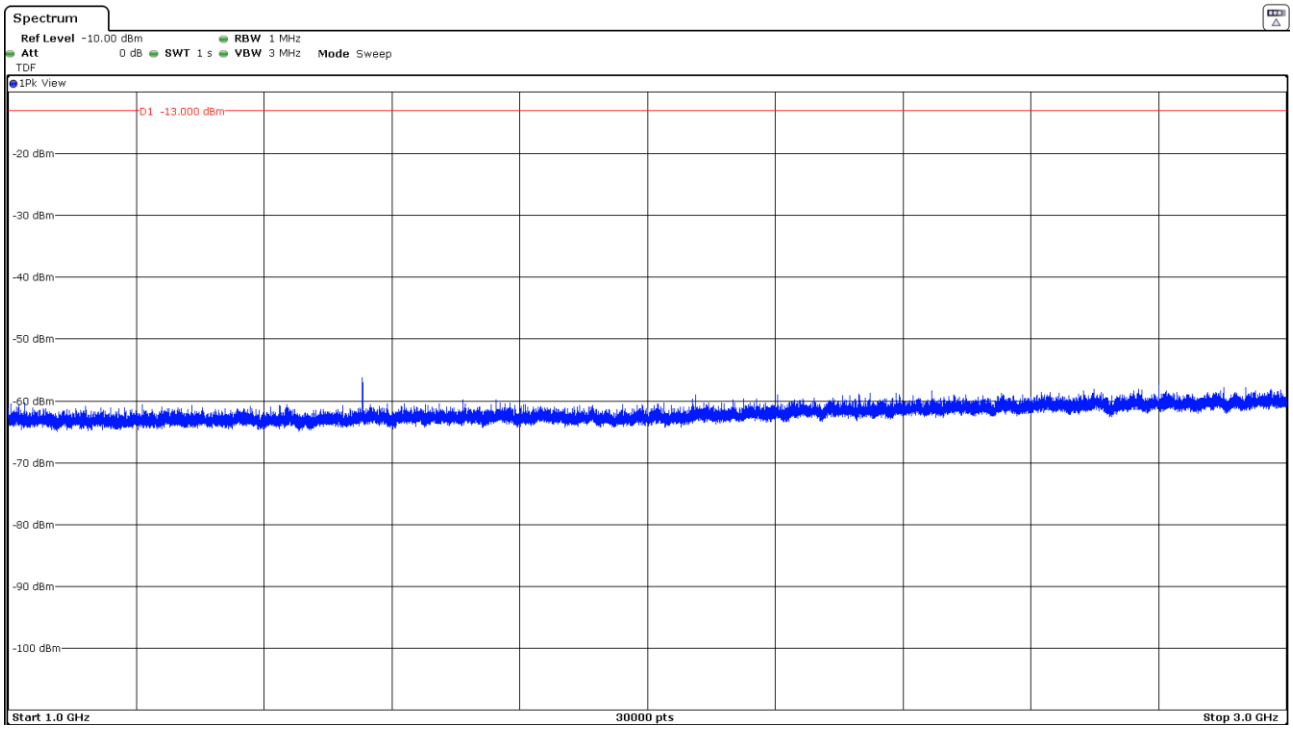
CHANNEL: HIGHEST



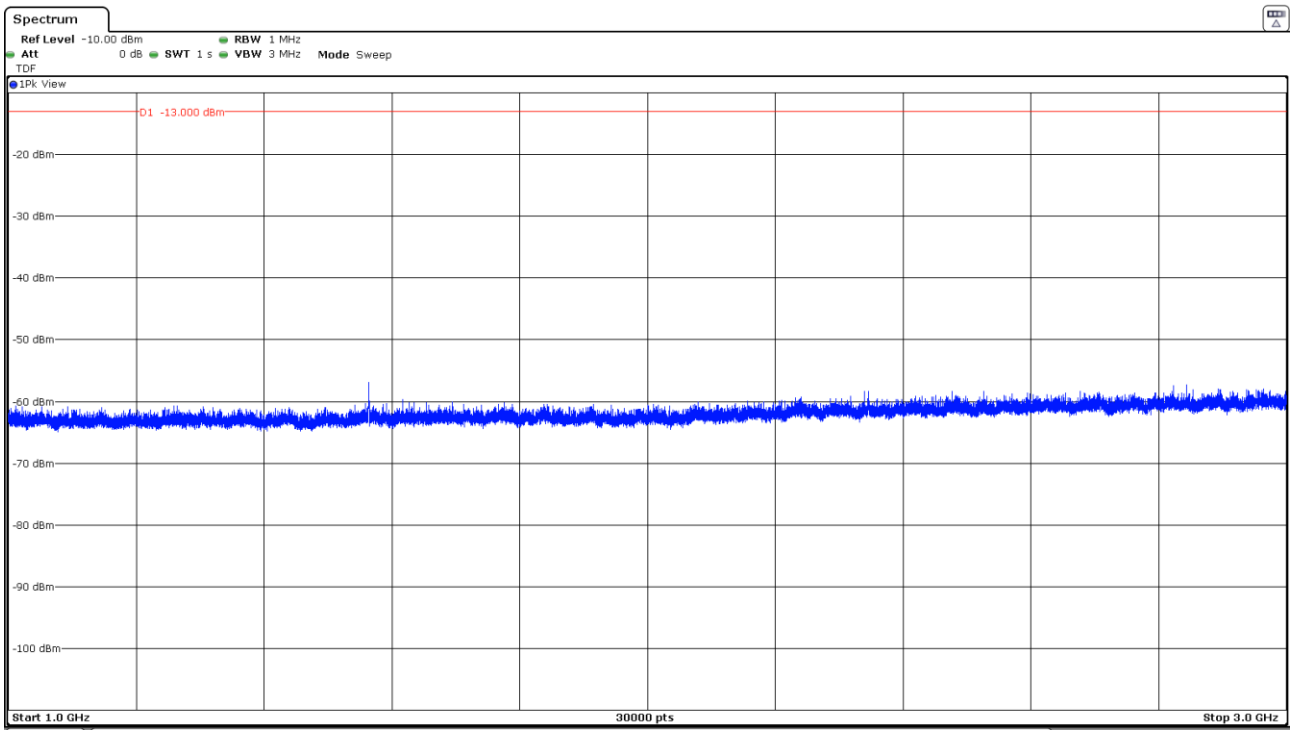
Note: The peak above the limit is the carrier frequency. The peak at 751MHz corresponds to the downlink signal.

Frequency range 1 GHz to 3 GHz

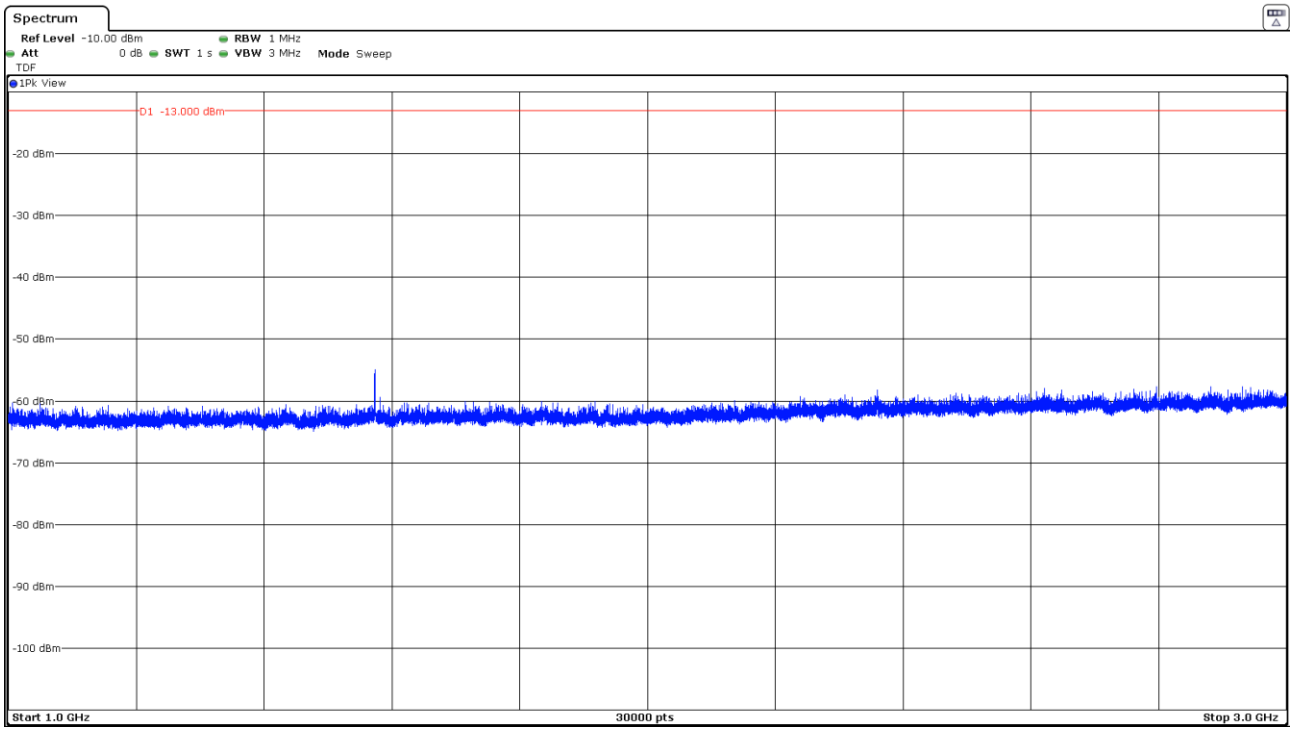
CHANNEL: LOWEST



CHANNEL: MIDDLE

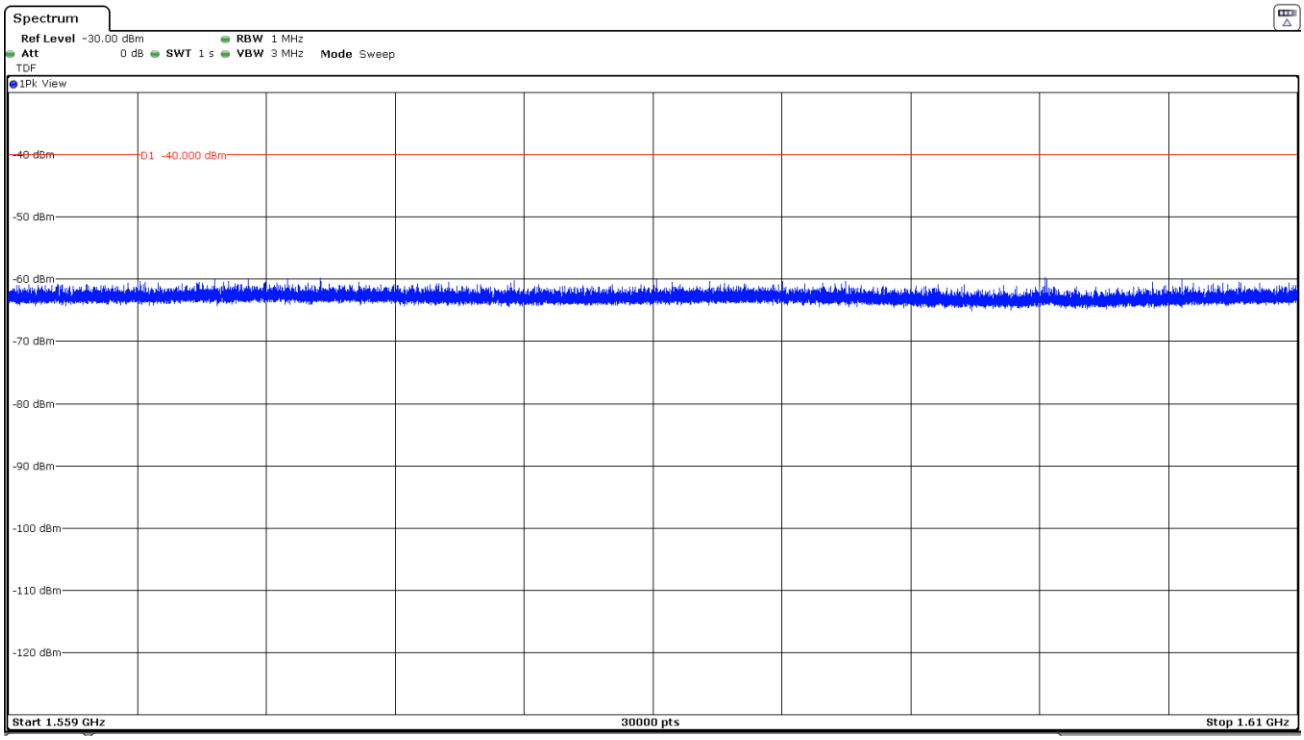


CHANNEL: HIGHEST

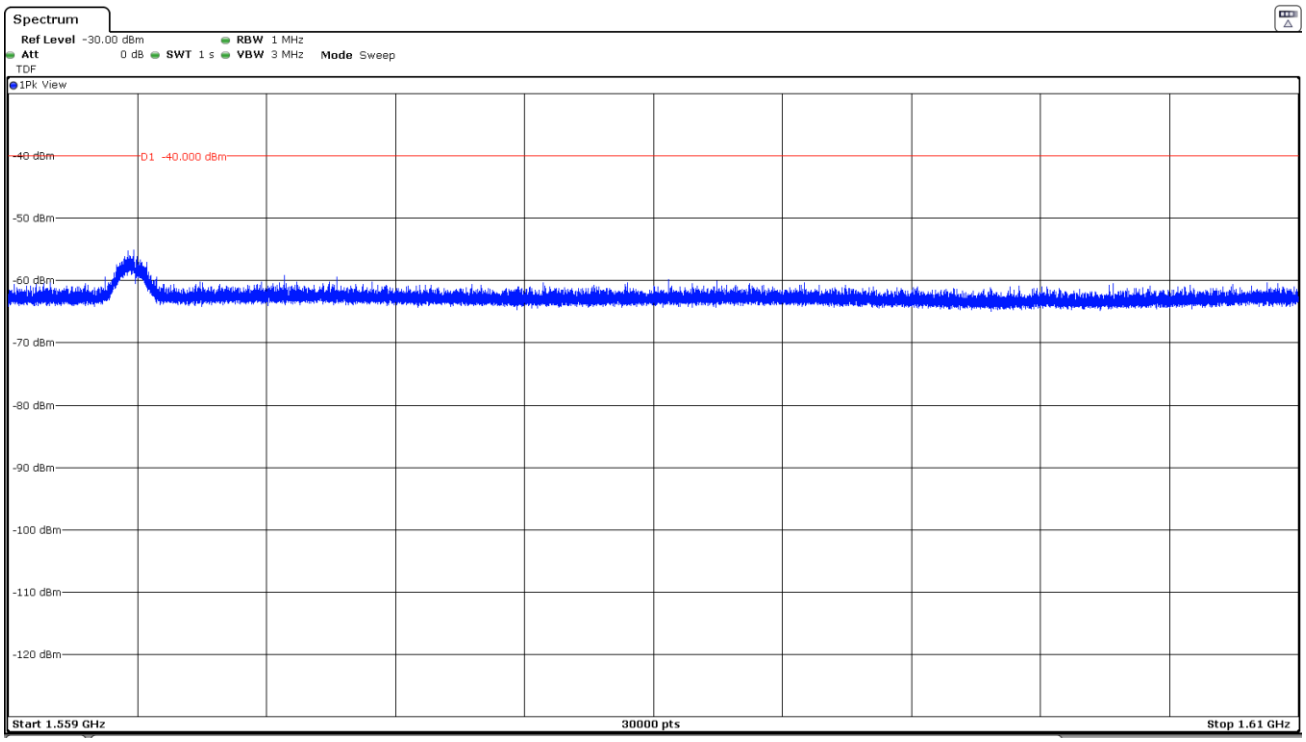


Frequency range 1559 MHz to 1610 MHz.

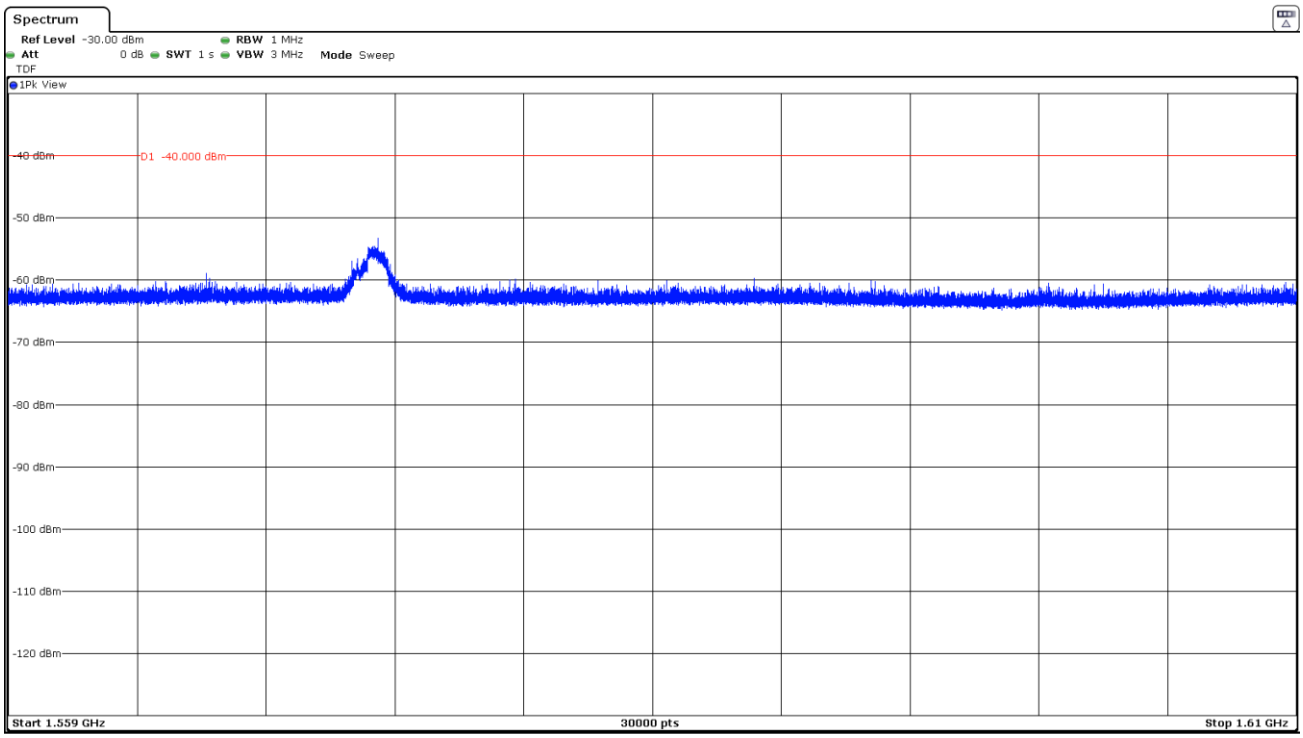
CHANNEL: LOWEST



CHANNEL: MIDDLE

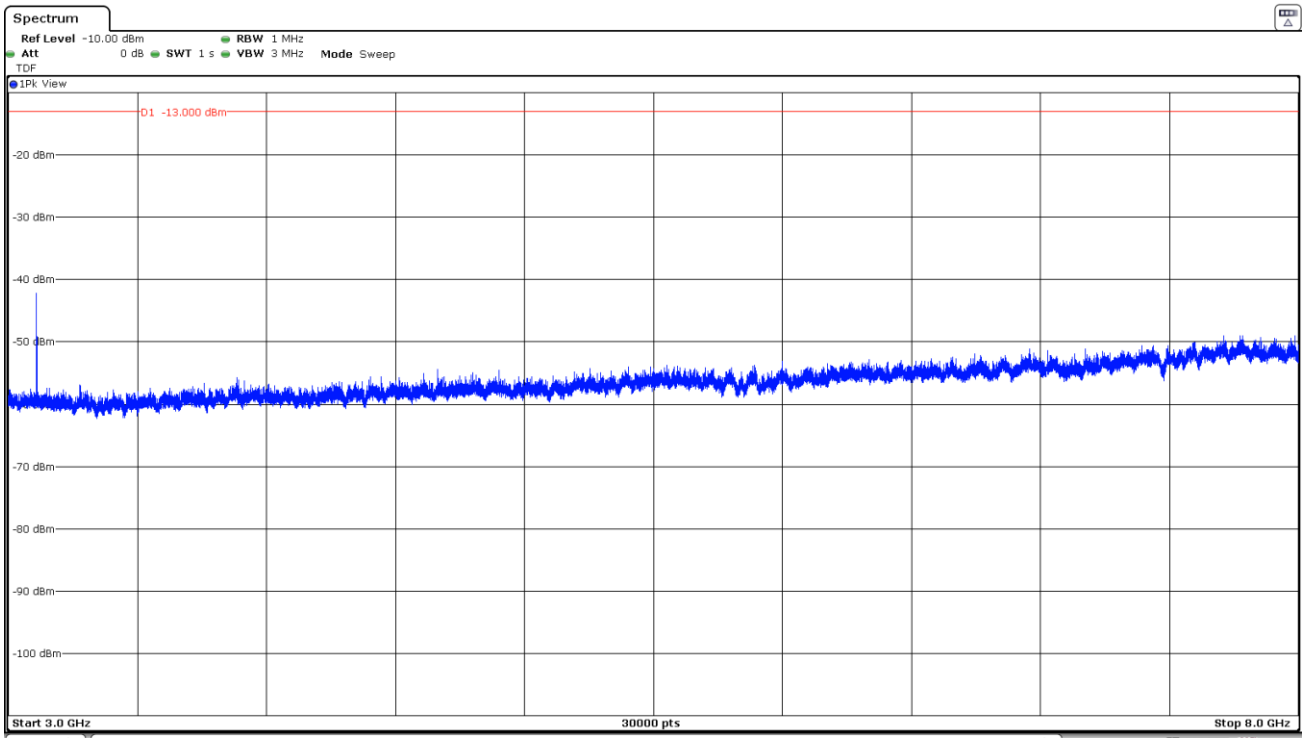


CHANNEL: HIGHEST

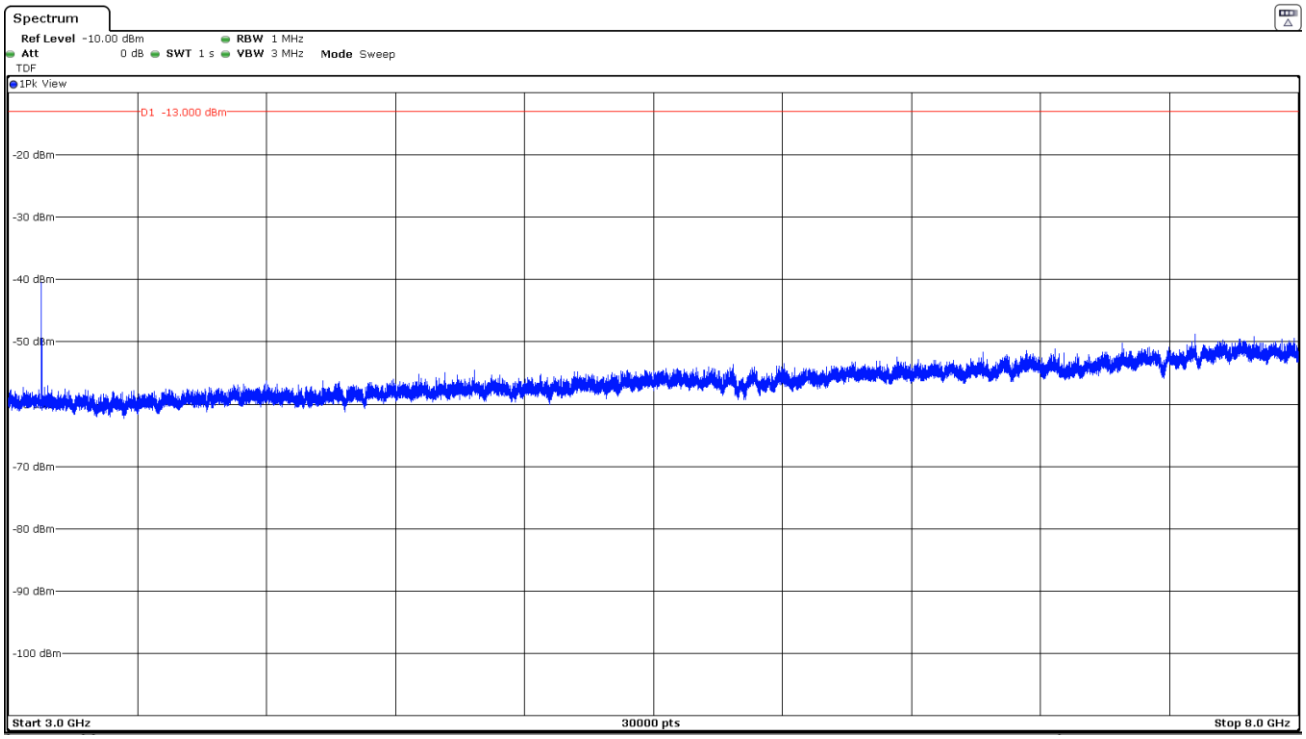


Frequency range 3 GHz to 8 GHz

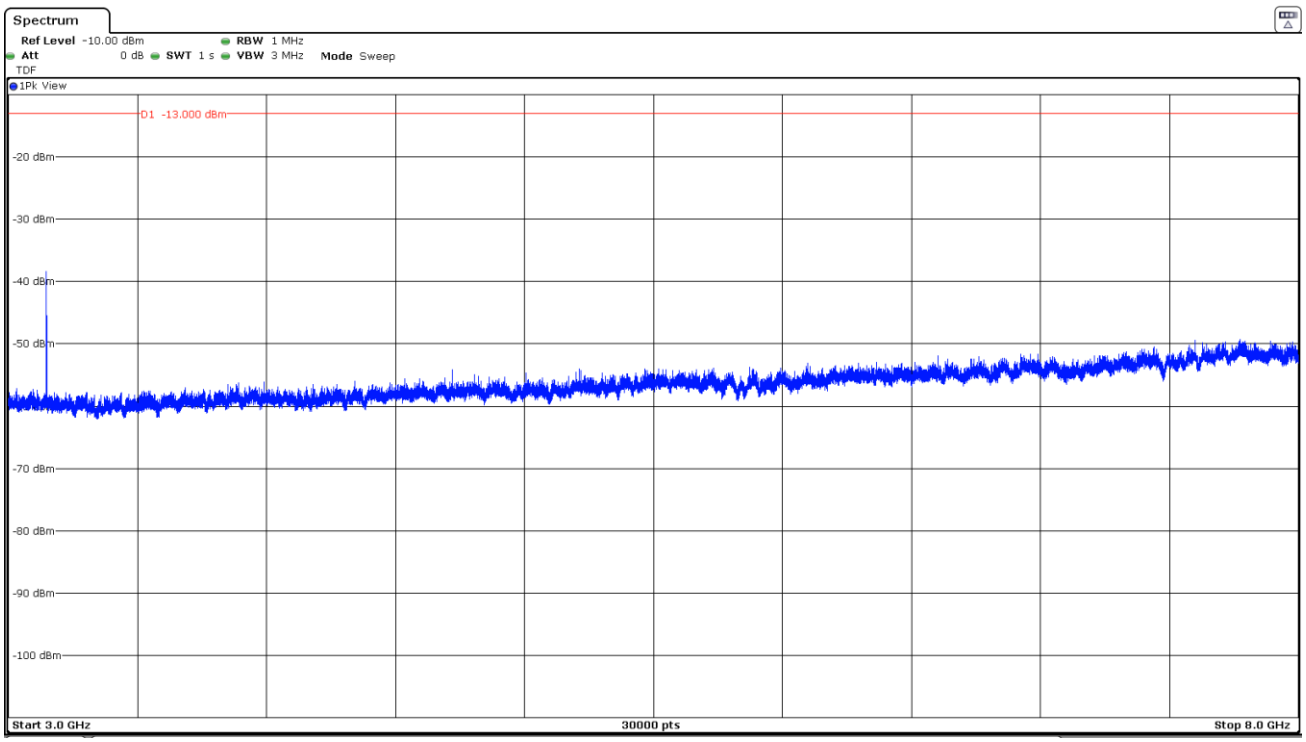
CHANNEL: LOWEST



CHANNEL: MIDDLE



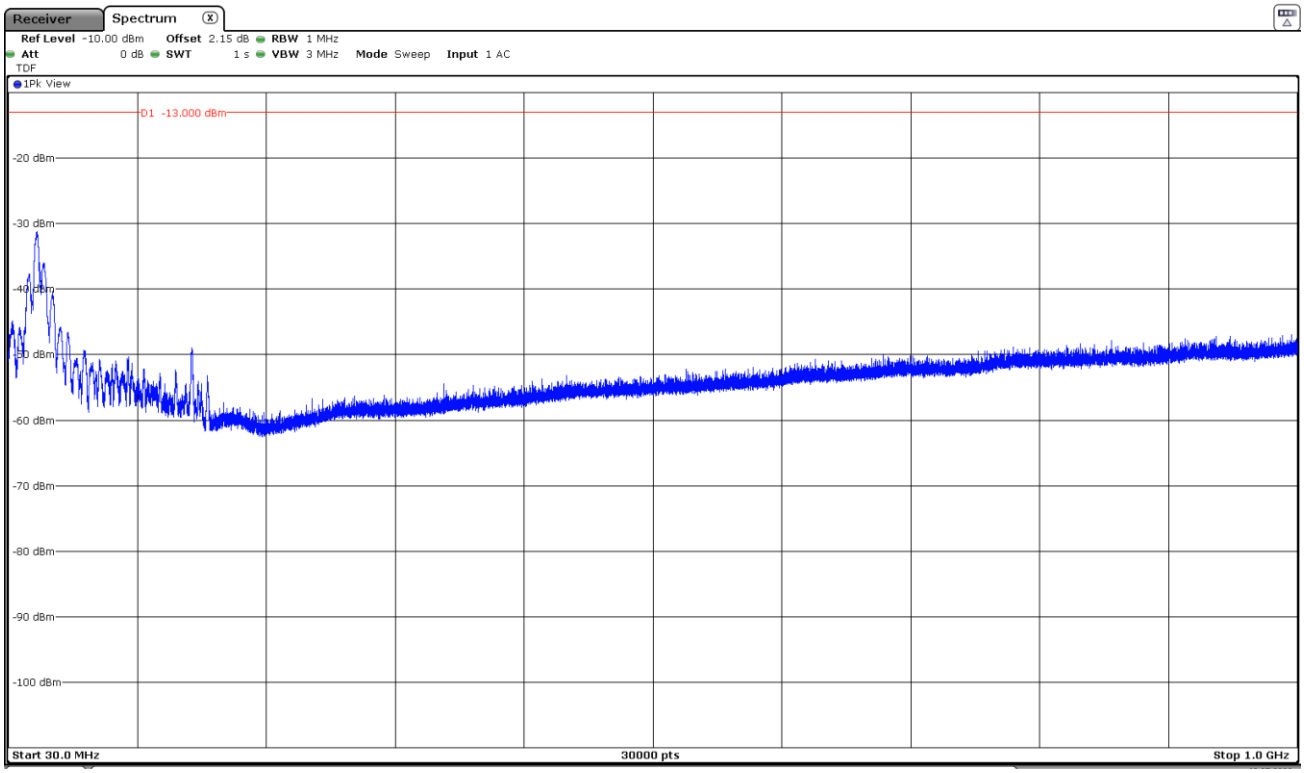
CHANNEL: HIGHEST



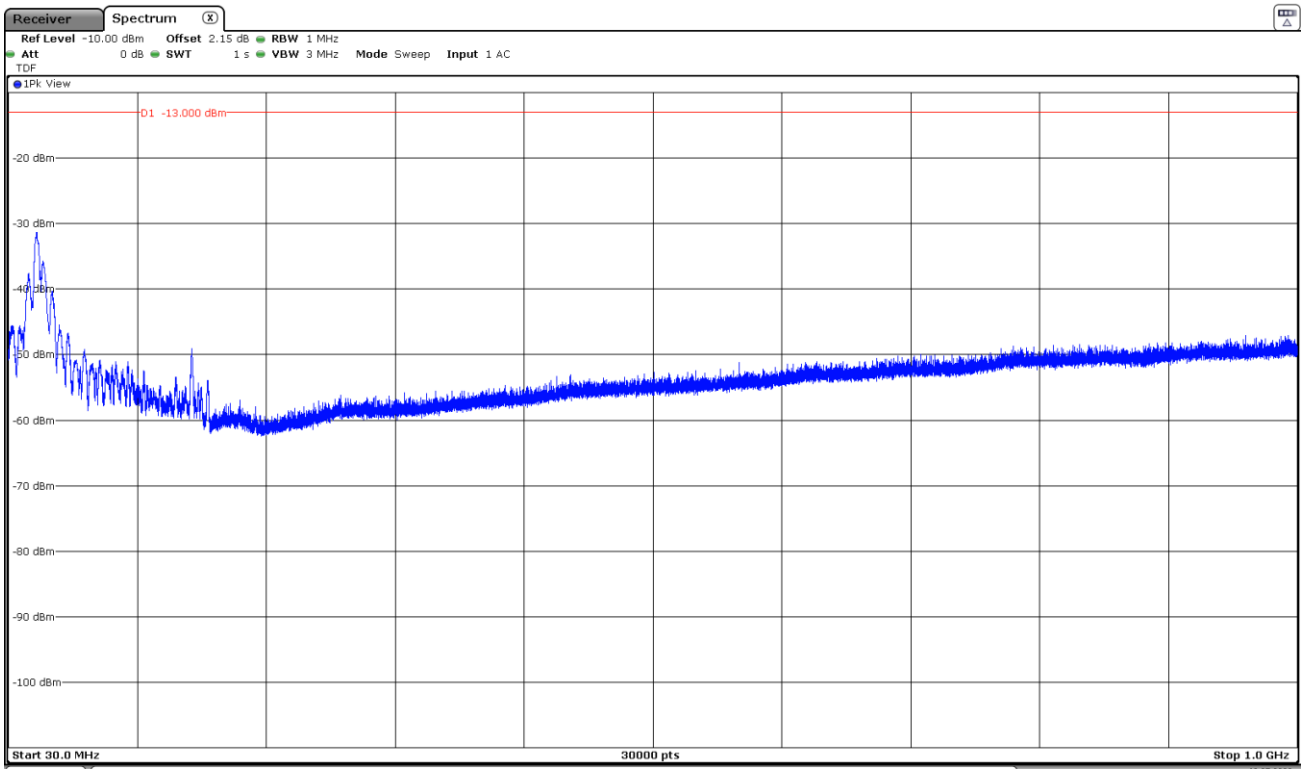
NBIoT Band 66

Frequency range 30 MHz to 1 GHz

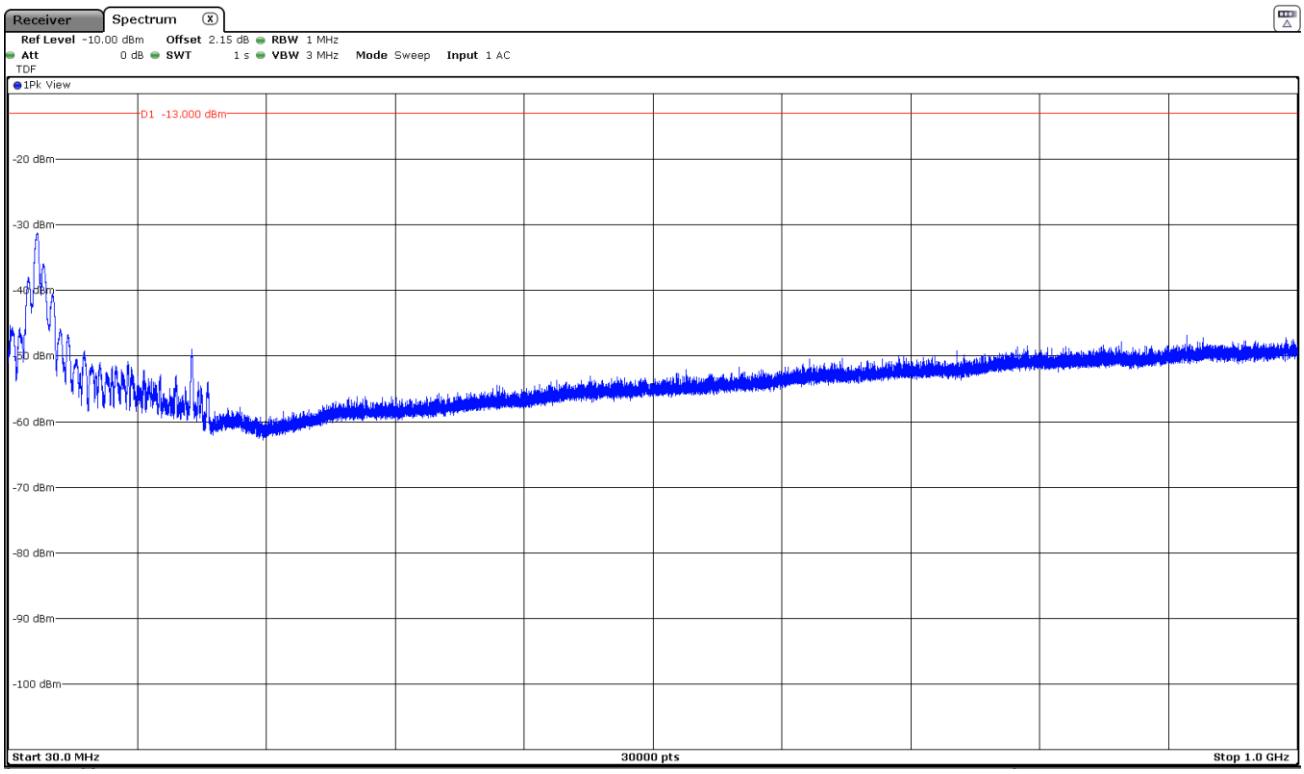
CHANNEL: LOWEST



CHANNEL: MIDDLE

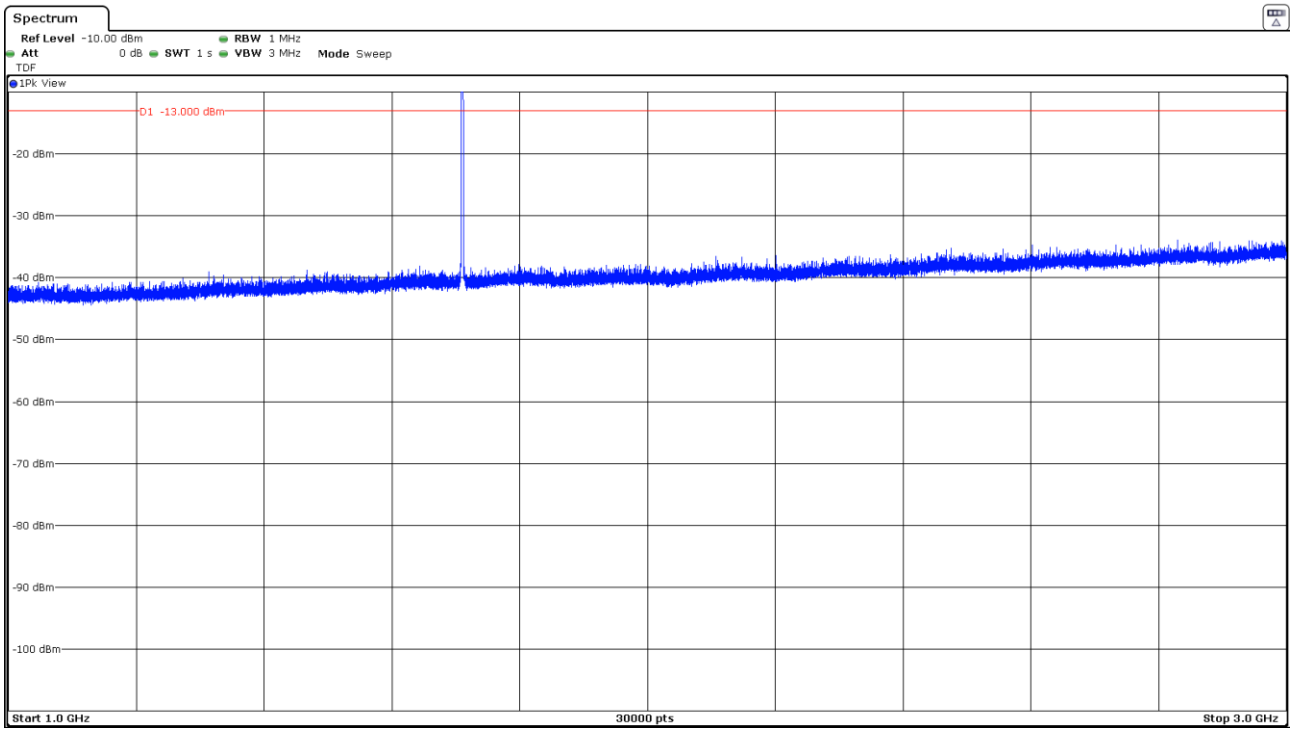


CHANNEL: HIGHEST



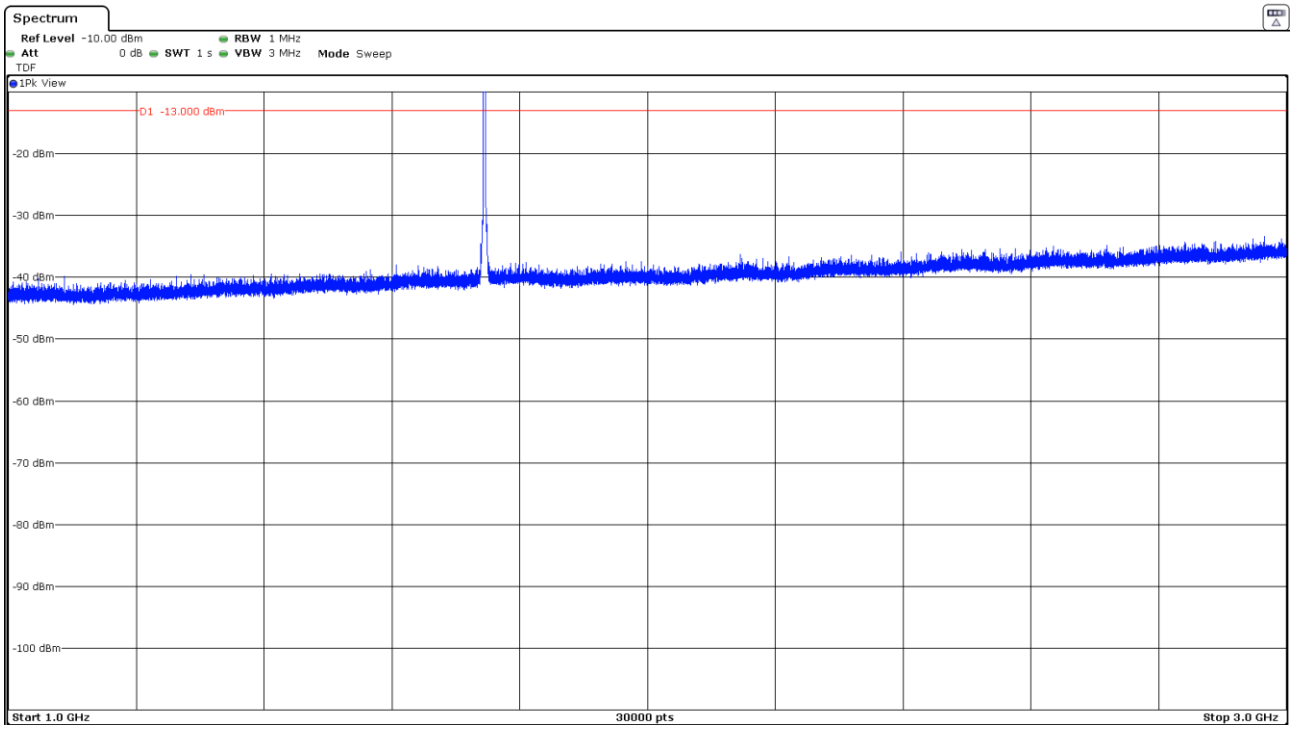
Frequency range 1 GHz to 3 GHz

CHANNEL: LOWEST



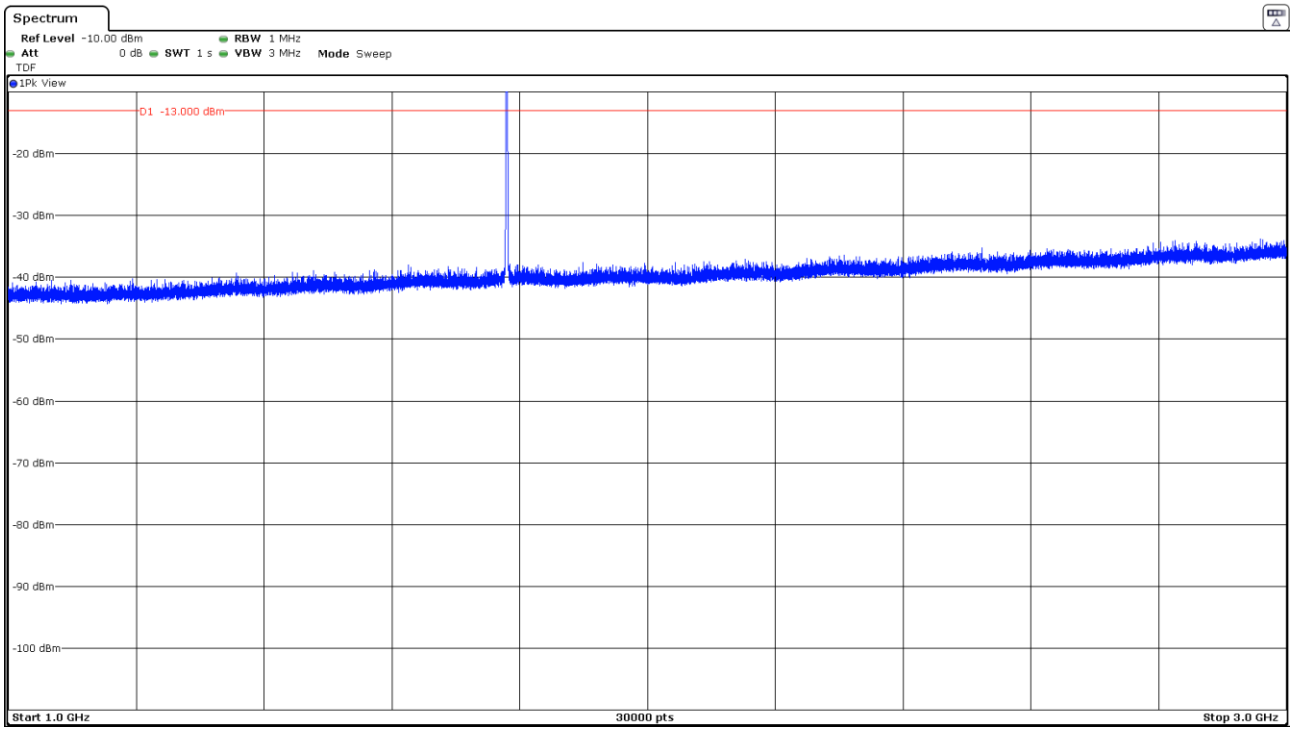
Note: The peak above the limit is the carrier frequency.

CHANNEL: MIDDLE



Note: The peak above the limit is the carrier frequency.

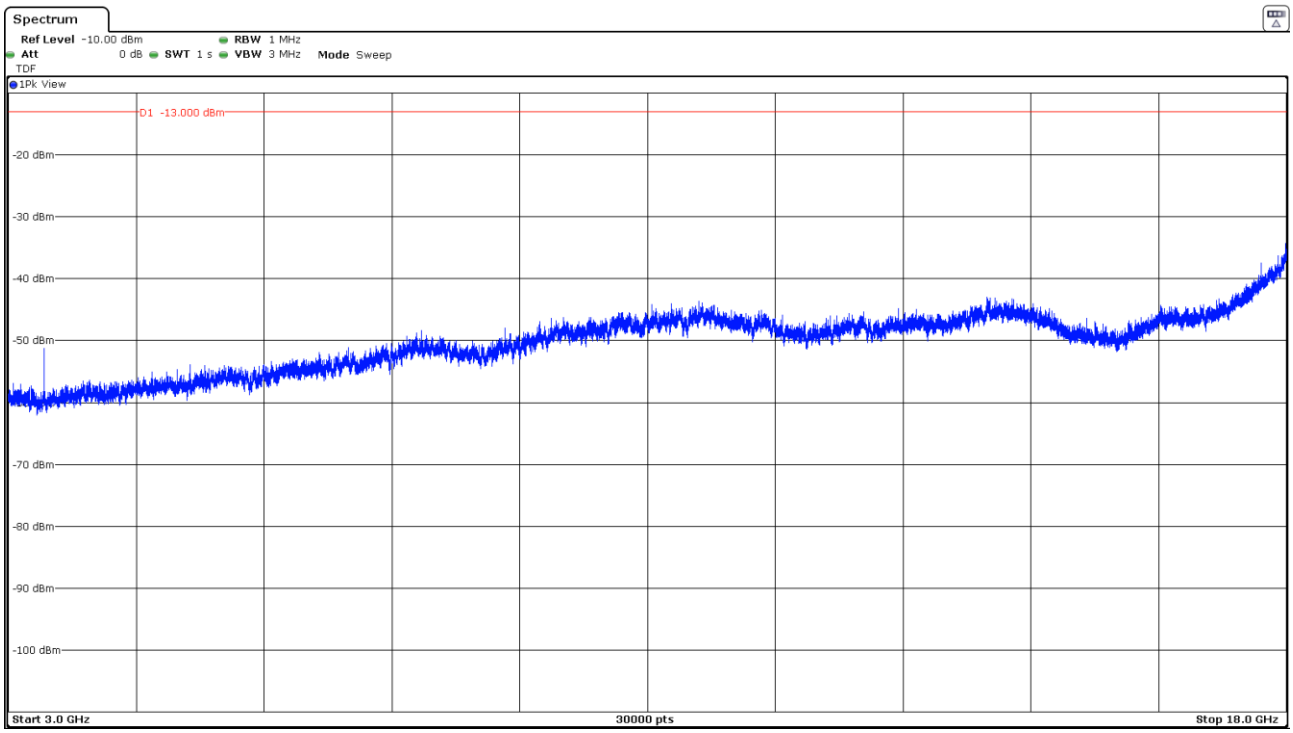
CHANNEL: HIGHEST



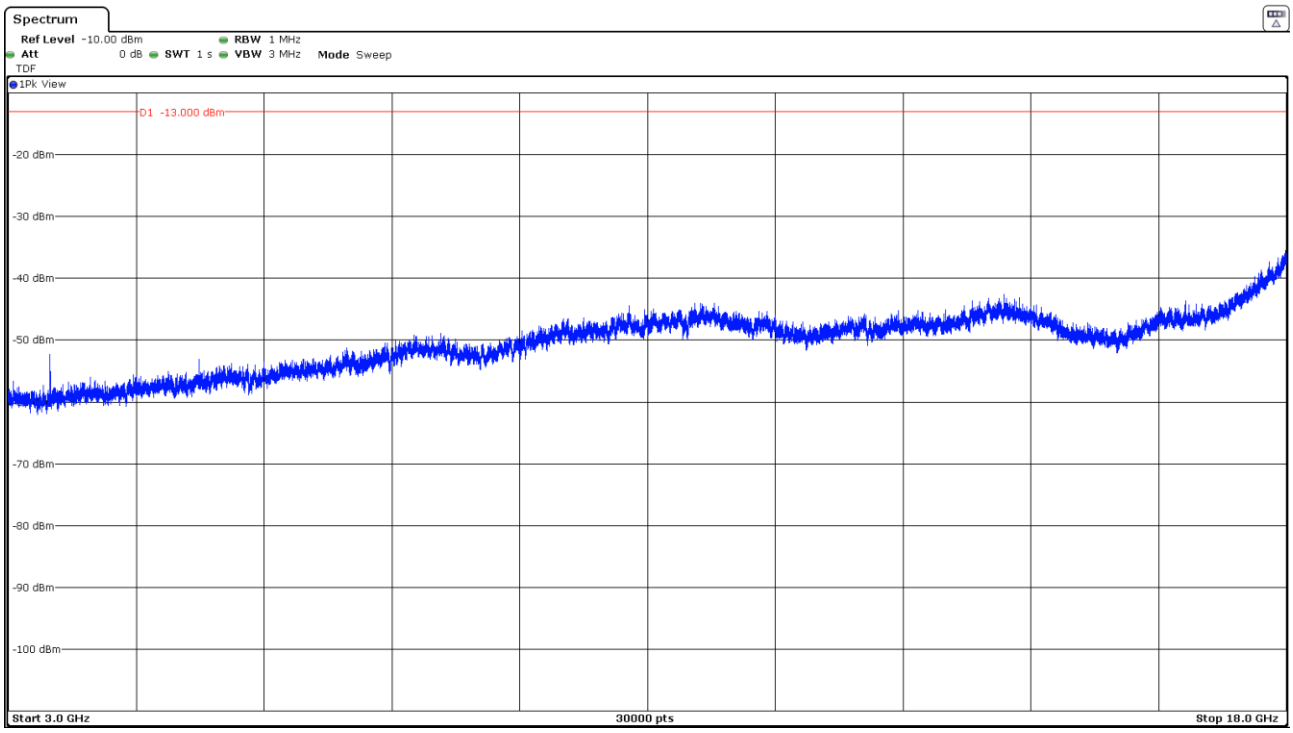
Note: The peak above the limit is the carrier frequency.

Frequency range 3 GHz to 18 GHz

CHANNEL: LOWEST



CHANNEL: MIDDLE



CHANNEL: HIGHEST